Compressed Air Magazine

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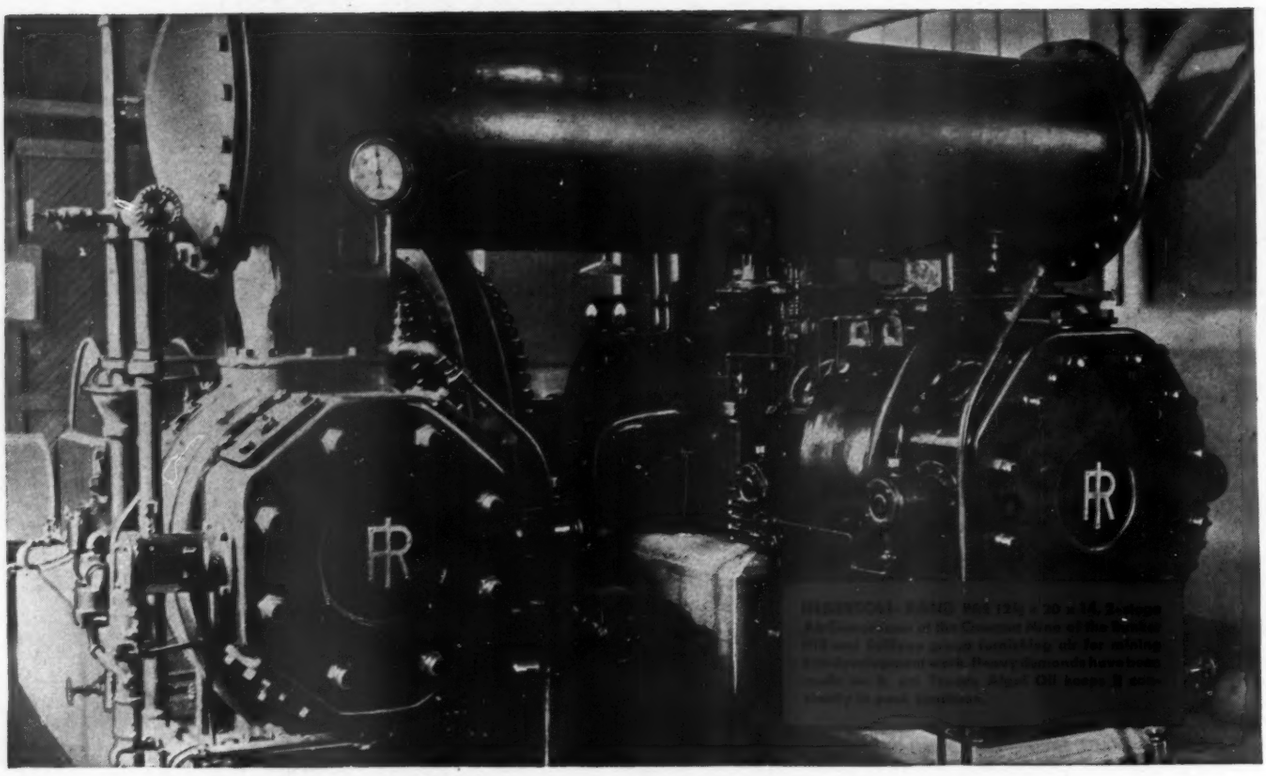
DRILLING IN ALLEGHENY TUNNEL, PENNSYLVANIA TURNPIKE



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ON THE COVER

SIX of the seven Pennsylvania Turnpike tunnels were partially excavated more than half a century ago. Allegheny Tunnel is the only one now being driven as a completely new bore. A top heading was advanced from each portal a distance of about 400 feet, and steel ribs set to support the roof. The remaining bench, approximately 12 feet high, was then removed by the method illustrated on our cover. Six Ingersoll-Rand DA-35 drifter drills, equipped with power feeding devices, were mounted on a quarry bar 33½ feet long. A round consisted of about 40 holes, the maximum depth of drilling being 12 feet. Jackbits were used, and the man in the foreground is removing one from a Jackrod. After the bench had been excavated the same distance as the top head, full-face drilling with a drill carriage was adopted.

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IN THIS ISSUE

WE PRESENT our third article on the Pennsylvania Turnpike—a description of the seven tunnels through the higher ridges of the Alleghenies. The enlarging of the partly driven old bores left by the railroad builders of 1884-5 poses many problems for the contractors; and progress is now necessarily slower than it will be when all the drilling faces are in solid rock.

•

THE principal point of interest in connection with the building of the Narrows Bridge at Tacoma, Wash., is the ingenious scheme by which the two main pier caissons were anchored during their sinking. Our article covers this phase of the operations and describes the work in general.

•

AUTOMOBILE washing under prevailing methods is an onerous job at the best. Service stations make no profit on it, and car owners object to the time it takes. Now an automatic washer promises to remedy both these difficulties. *Shower Baths for Automobiles* tells the story.

•

WE ARE all familiar with the use of hollow building tiles and concrete blocks to provide strength without weight. European constructors are applying the same principle and are making concrete columns, beams, flooring, etc., by utilizing inflated rubber tubes as cores. Details of the process are given in the article starting on page 6040.

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MEDAL TO GOLDSMITH

AN ARTICLE in our July, 1939, issue described the turbine-electric tankship *J. W. Van Dyke*. Many of the facts were taken from a paper prepared for the 1938 annual meeting of the American Society of Mechanical Engineers by Lester M. Goldsmith, chief engineer of The Atlantic Refining Company. For his presentation Mr. Goldsmith has been awarded the society's Melville Medal, which is given annually for the best original paper on any mechanical engineering subject written for the society for discussion and publication.

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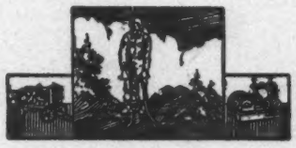

EDITORIAL CONTENTS

Pennsylvania Turnpike Tunnels—*C. H. Vivian* 6026
Unusual Problems Attend Narrows Bridge Construction—*James Bashford* 6033
Shower Baths for Motor Cars—*Allen S. Park* 6036
Air Puts Cavities in Building Materials—*A. W. Hoffmann* 6040
How Air Guns Work 6043
Steam-Generator for Small-Scale Operations 6044
Pneumatic Conveyor for Zinc Ore 6044
Editorials—The Trend in Toys—Turnpike Equipment 6045
Radiant Heat from Slag Used to Raise Steam 6046
New Scraper Mucking Manual 6046
New Air-Line Lubricator 6047
Industrial Notes 6047

ADVERTISING INDEX

Allis-Chalmers ..... Third Cover
American Air Filter Co., Inc. 13
American Brass Co., The 17
Atlas Steel Casting Co. 24
Bucyrus-Erie Company 22
Conrader & Co., R. 24
Cook, C. Lee 11
Coppus Engineering Corp. 26
Eimco Corporation, The 9
Garlock Packing Co., The 26
Hercules Powder Co., Inc. 20
Ingersoll-Rand Co. 4, 15-16, 21, 25
Jarecki Manufacturing Co. 25
Jenkins Bros. 14
Lebanon Steel Foundry 12
Madison-Kipp Corporation 27
Maxim Silencer Co., The 25
National Forge & Ordnance Co. 25
New Jersey Meter Co. 23
Norton Company 10
Rotor Tool Company 8
SKF Industries, Inc. 19
Socony Vacuum Oil Co., Inc. 6-7
Square D Company 24
Straight Line Foundry & Machine Corporation 23
Staynew Filter Corp. 3
Texas Company, The ..... Second Cover
Timken Roller Bearing Co., The ..... Fourth Cover
Toledo Pipe Threading Machine Company, The 23
Vogt Machine Co., Inc., Henry 18
Waukesha Motor Company 5
Willson Products Incorporated 24

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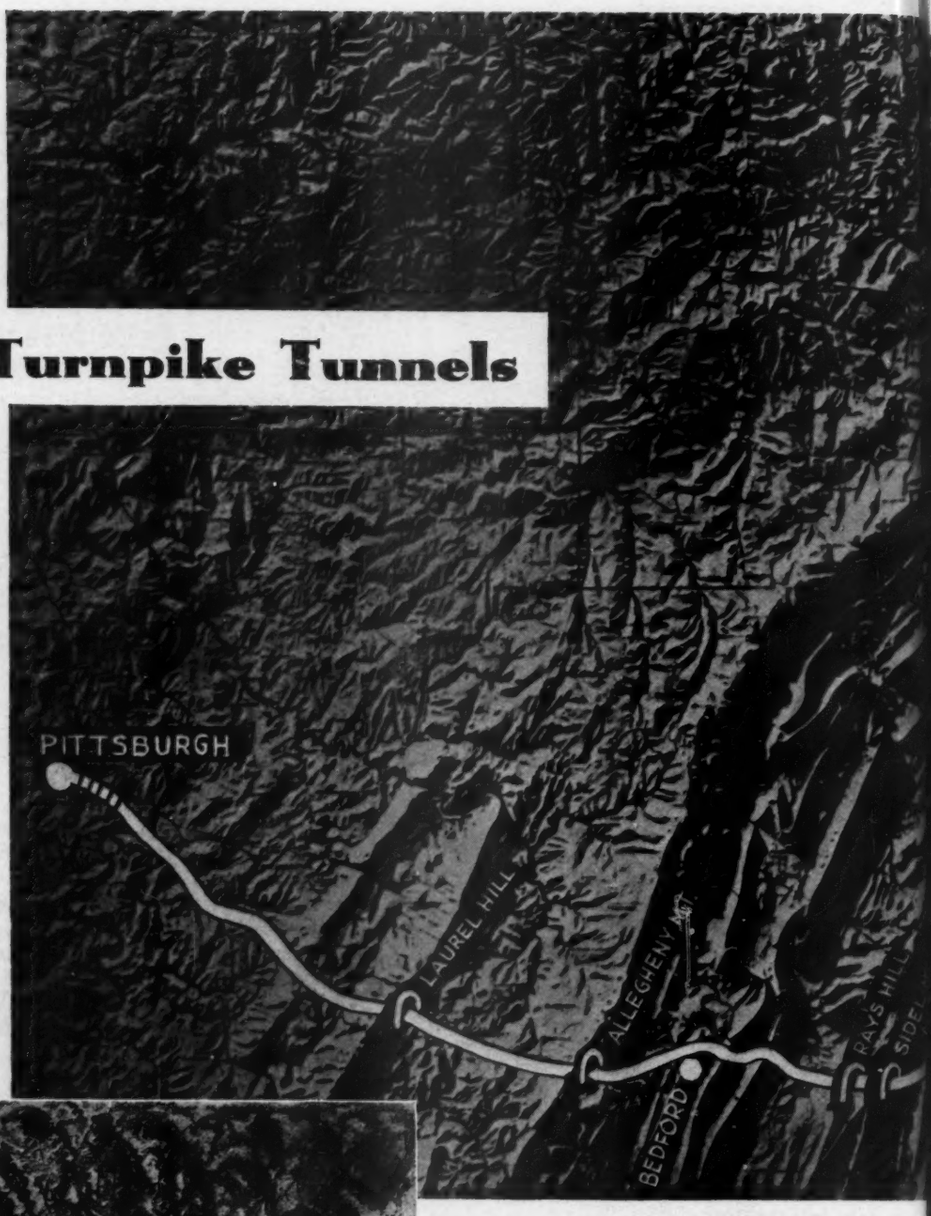
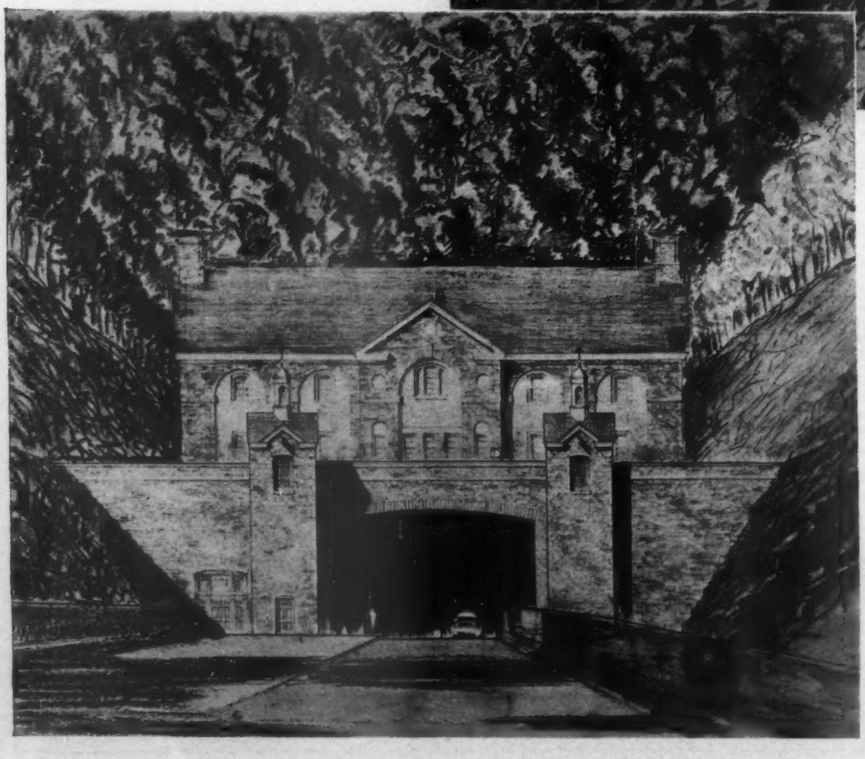
Pennsylvania Turnpike Tunnels

C. H. Vivian



DESIGN FOR TUNNEL ENTRANCE

There will be a building at all but one of the fourteen tunnel portals. They will contain ventilating machinery, emergency electric generating sets, fire-fighting apparatus, and a truck for towing out cars that may become disabled in a tunnel.

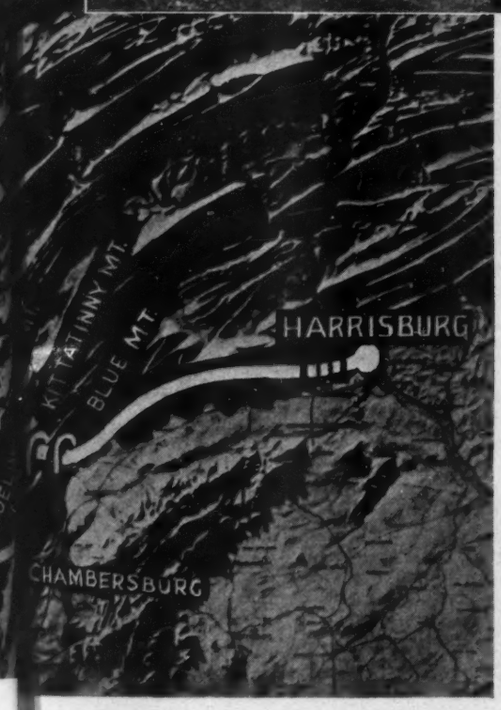


SEVEN tunnels are included in the route of the Federal-financed Pennsylvania Turnpike, the $61,000,000 superhighway now being built between Harrisburg and Pittsburgh by the Pennsylvania Turnpike Commission. With all paving operations to be suspended during the winter months, and work on open-air grading and structures largely curtailed, the excavating of these tunnels will be the principal activity from now until spring. The highway is scheduled to be ready for use by July 1, 1940, and in an effort to reach that objective, tunneling is being carried on with all possible dispatch consistent with safe practice.

As of November 20, the work on the entire 161-mile line was 65 per cent completed. Grading and drainage structures along 78 miles were entirely finished, and along the remainder of the route they were from 65 to 95 per cent completed. Fourteen contracts had been awarded for the paving

EAST PORTAL KITTATINNY TUNNEL

Below is an Ingersoll-Rand Type FS Motorblower that is used for ventilating the workings. It has a rated capacity of 12,000 cubic feet of air at 2 pounds pressure per minute. It is equipped with a 4-way reversing valve that makes it possible either to exhaust air from the tunnel, which is done immediately following blasting, or to blow fresh air into it. The view at the left shows the same portal of the old South Pennsylvania Railroad tunnel as it appeared before the present project was started.



of 86 miles, and substantial progress had been made on four of them. All told, 61 contracts, aggregating $42,390,942, had been awarded, and it was announced that all the remaining ones would be let by February 1.

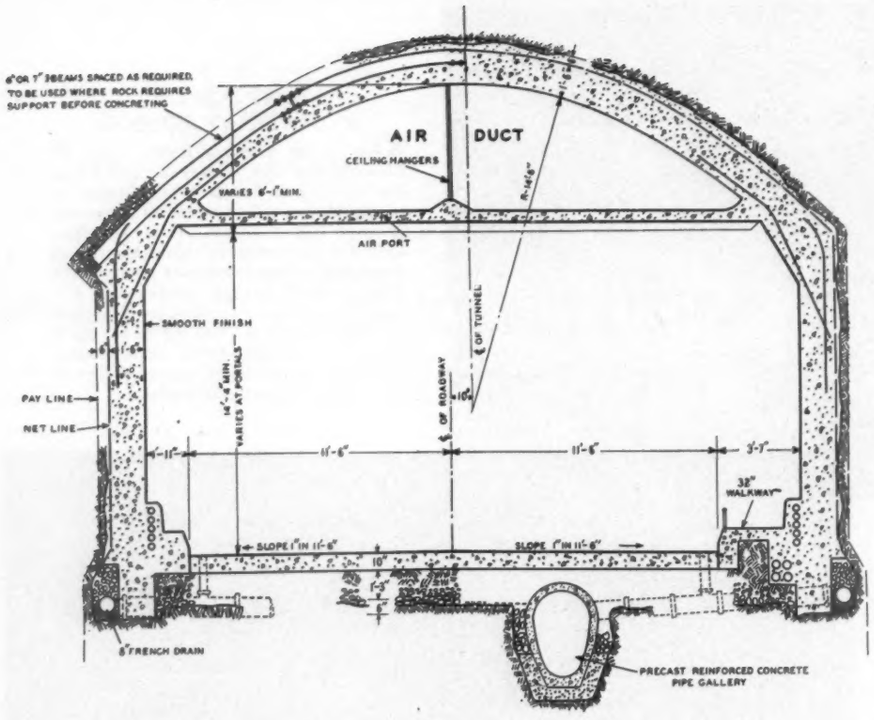
On the same date, November 20, the 12 miles of tunnels and tunnel approaches were about 33 per cent completed. About half this mileage consists of approaches, and on these the work is far advanced. This leaves the actual tunneling as the most backward of the current operations; and as the highway cannot be put in service until the tunnels are finished, the importance that attaches to their boring is apparent. Fortunately, bad weather does not impede tunnel driving, and every effort is being exerted to make maximum progress during the winter.

The combined length of the tunnels will be 34,157 feet, or 6.47 miles. The highest point on the highway will be Elevation 2,456 at Laurel Hill Tunnel, the westernmost of the bores. By going through the higher mountains instead of over them, cars negotiating the highway will be saved an aggregate vertical climb of more than 4,000 feet. The resultant reduction in time will be great, particularly for heavy trucks that climb at low speeds. Safety of travel will be markedly improved, for curves and steep grades will be eliminated and the hazard of fog on the mountain tops removed.

An accompanying cross-sectional drawing shows the principal construction details of the tunnels. As completed, that portion of the bores that the users will see will be 28½ feet wide and 14⅓ feet high. There will be two 11½-foot roadways, with a walkway 32 inches wide at one side. The concrete lining of the side walls and roof will be either 12 or 18 inches thick, depending upon the stability of the rock traversed. The concrete will be reinforced, and the steel posts and ribs used to support the roof during excavating also will be embedded in it to give it additional strength. Beneath the 10-inch reinforced-concrete pavement will extend a precast reinforced-concrete drainage gallery to which, at frequent intervals, will run laterals connecting it with drains at each side that will collect water from both inside and outside the tunnels. Ducts on each side, encased in the concrete, will carry electric wires for adequately lighting the interior, as well as wires for the telephone and signal systems.

Overhead, between the roadway ceiling and the arched roof of the concrete lining, will be a duct for conveying fresh air throughout the length of each tunnel. The air will be introduced into the roadway area through ports at regular intervals and will carry fumes from the cars out through the portals. Fresh air will be supplied by fans housed in buildings to be erected over the portals. There will be thirteen of these structures, one at each tunnel entrance except at Ray's Hill Tunnel, which will be so short that a single plant, at the west end, will suffice.

Each building will contain two motor-driven fans, each capable of forcing into the tunnels 175 cubic feet of air per minute for each foot of their length. Each fan will be arranged for driving by either of two motors, a large one for full-speed operation and a smaller 2-speed unit for half- and quarter-speed operation. The air will be taken into each ventilation building through louvres, in the rear wall, having a combined area of 1,200 square feet. Suf-



TYPICAL TUNNEL CROSS SECTION

ficient fresh air will be forced into the tunnels to keep the carbon-monoxide content down to not more than 4 parts in 10,000 at all times, The air in various sections of the tunnels will be continually sampled, and an automatic carbon-monoxide analyzer in each portal building will show a continuous graphic record of the carbon-monoxide content. Whenever this analysis indicates that more fresh air is required, it can be supplied merely by speeding up the fans. At the six tunnels having two ventilating plants, air will be introduced continually at both ends. The overhead duct will be bulkheaded at the midway point to make each portal system independent of the other. A supervisor at one portal will be able to regulate the fans at the other portal by remote control. A garage in each building will house service trucks for emergency use in towing out cars that may become stalled in the tunnels.

These will be the first tunnels in the United States to be lighted by mercury-vapor lamps. The illumination will approximate daylight as closely as possible and will be increased at the portals so that there will be no appreciable diminution of light for daytime drivers entering the bores at relatively high speeds. Current will be supplied by several power companies operating in the areas concerned, and the lines will be interconnected. In case of power failure, storage batteries in the portal buildings will automatically begin feeding current to a system of tungsten lamps in the tunnels. If the interruption lasts more than ten seconds, gasoline-engine-driven generator sets will be automatically started.

During the construction back in 1884 and 1885 of the old South Pennsylvania Railroad, whose right of way is being followed in part by the turnpike, tunnels were partially driven at all seven locations where work is now underway. None of the old bores had been holed through when the project was abruptly terminated; but they had been advanced a combined distance of 21,231 feet, consisting of 9,773 feet of double-track width and 11,458 feet of single-track width. The existence of the two widths came about through a decision to narrow the tunnels to single-track size after they had been excavated for double tracking for considerable distances.

In six of the seven tunnels the sections previously excavated are being utilized. The exception is Allegheny Tunnel, where the old workings were in such a bad condition that it was decided to drive a new bore. This will run parallel to and only 85 feet away from the old one. At Laurel Hill Tunnel, the railroad builders had advanced only from the west portal, although the east portal had been opened up. The 773 feet of bore that exists is being incorporated in the new tunnel; but the remainder of the line will deviate from that laid out half a century ago. As a result, the east portal will be approximately 1,000 feet distant from the site of the old one. This change will shorten the route by 1,025 feet and also eliminate the expensive and troublesome operation of restoring the old east portal, which is caved in.

By driving a completely new Allegheny Tunnel, the footage of the old workings being utilized is reduced to 17,300, of which 7,803 feet is double-track width and 9,497 feet is single-track width. Offhand it would seem that the existence of these previously excavated sections would considerably expedite the driving of the tunnels; but this has not proved to be entirely true. If the old workings were not there, the total tunneling required would amount to approximately 1,000,000 cubic yards: by taking advantage of them, it has been reduced by some 300,000 cubic yards. This results in a monetary saving estimated at $2,000,000. It is questionable, however, whether it has simplified the task of the contractors or enabled them to proceed at a faster pace.

The enlarging of the old bores is essentially a trimming operation by which relatively thin layers must be removed from both sides and from either the top or bottom, or both. Drilling progress under these conditions is slower than it would be if a full face were being attacked, and greater safety precautions must be taken than when driving through virgin ground. Because they have been exposed to the air for more than 50 years, and because of the action of percolating ground water, the rock faces in many areas have inevitably become unstable, and at numerous locations there have been falls from the roof. These "ticklish" spots necessitate very careful procedure. In Tuscarora Tunnel, fallen rock has completely blocked the old opening at

Contractor	Tunnel	Length	Driven in 1884-5	Undriven	Bid Price
Bates & Rogers Construction Corp., Chicago, Ill.	Blue Mt.	4,195 ft.	3,062 ft.	1,133 ft.	$2,920,123
	Kittatinny Mt.	4,583 "	4,032 "	551 "	
B. Perini & Sons Framingham, Mass.	Tuscarora Mt.	5,236 "	3,767 "	1,469 "	2,055,939
The Arundel Corporation Baltimore, Md.	Sideling Hill	6,626 "	3,247 "	3,379 "	2,444,527
Mason & Hanger Company, Inc. New York, N. Y.	Ray's Hill	3,419 "	2,418 "	1,001 "	1,549,718
Guthrie-Marsch-Peterson Company Chicago, Ill.	Allegheny Mt.	5,926 "	None	5,926 "	2,672,188
Hunkin-Conkey Construction Company Cleveland, Ohio	Laurel Hill	4,172	773 "	3,399 "	1,920,281

a point about 366 feet in from the west portal. Where voids in the roof or sides exist, or where they may occur during the enlarging operations, they must be filled, either with rock or concrete, and suitable measures taken by "guniting," or otherwise, to stabilize the rock formations to prevent further detachment of material.

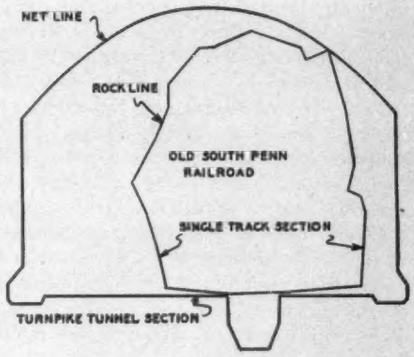
The rocks being penetrated are all of sedimentary origin, with sandstones and shales predominating. They exhibit distinct bedding planes and have been considerably faulted by repeated folding during the formation of the mountain ridges in which they occur. For the most part the strata dip at angles of from 30 to 90°, but along the lines traversed by Laurel Hill, Allegheny, and Sideling Hill tunnels they lie in a more nearly horizontal position. Geological maps showing cross sections along all the tunnel routes were made available to contractors by the turnpike commission, the data for them having been obtained by visual examination of the rocks exposed in the old workings and by taking more than 15,000 feet of cores from borings in the unexcavated sections. These investigations revealed only one area that promised to prove so troublesome as to call for special handling. This is in Kittatinny Tunnel, where the line will have to be carried through a zone of sand, 200 feet wide, that is under approximately 200 pounds hydrostatic pressure. A separate contract for $75,000 covers this section.

The seven tunnels and their approaches are being constructed by six contractors, the closely adjoining Blue and Kittatinny bores having been included in one contract. The six awards total $13,562,776, or a little more than 22 per cent of the estimated cost of the entire highway. The contracts cover approximately 7½ per cent of the line. The tunnel contractors will not erect the ventilation buildings: they are to be built and equipped under separate awards. The names of the tunnel contractors, with pertinent data on each award, are listed elsewhere in this article. Among those having work underway are some of the leading tunneling concerns in the United States.

A trip over the route reveals that there is considerable variation in the construction methods being employed; but it must be borne in mind that so far most of the work has consisted of enlarging the old bores. When all the headings are being driven full face, then the procedure will probably be much the same throughout. All tunnels are being driven from both ends; and separate compressor plants have been set up at each end to furnish the necessary air for operating drills and other essential equipment at each heading. Direct-connected, electric-driven units predominate, with belt-driven machines second in numbers.

All the contractors will use drill carriages or "jumbos" for their full-face operations. Rail-mounted carriages or gantries, with central openings large enough to permit loading shovels and trucks to pass through them, will be employed at six of the fourteen headings. This type of construction makes it unnecessary to take the carriages out of the tunnels while mucking is in progress. Truck-mounted carriages are of two classes: One contractor is using a unit that is designed to drill the entire face at one time and that is built up on two trucks, while smaller so-called half jumbos that drill one-half the face at a time are mounted on one chassis. Truck-mounted carriages are run out beyond the portals after each drill round to clear the way for the mucking equipment.

Most drill carriages will carry eight or nine drills, although the number is subject to change after full-face operations have been conducted long enough to indicate how the work can be most effectively done. Minor alterations of drill carriages will very



COMPARISON OF SIZES

The smaller sketch shows a single-track section of old tunnel. The double-track sections were 27 feet wide and 22 feet high.

EAST PORTAL, ALLEGHENY TUNNEL

This is an entirely new bore because the condition of the partly driven old one was found to be too poor to warrant its enlargement and completion. The portal of the old tunnel is visible at the right. The water that filled it to a depth of several feet was used for a time for cooling compressors and other machinery and was also piped to the drills operating in the new bore. The Ventube extending into the new tunnel conveys fresh air from a Motorblower to the workings.

likely also be made to meet changing conditions as they develop. Drifter drills of 3½-inch cylinder diameter will be generally employed, and most of them will be equipped with power-feed mechanisms that eliminate hand cranking and speed up drilling. Most contractors are aiming at an advance of 10 to 12 feet with each round of drilling and shooting, and to obtain this they will use steels up to 13 or 14 feet long for finishing the holes. In addition to the mounted drifter drills, a great many hand-held drills of the Jackhamer type, as well as some stoping drills, will be used for trimming side walls, floor, and roof.

Contractors are not paid for any material broken outside of a line 6 inches beyond the net rock line prescribed for the cross section. To prevent excessive overbreak, care is taken not to locate the deep drifter holes too close to the desired limits. After each round is blasted and loaded out, any rock projecting inside the net line is drilled with the smaller machines. Pavement breakers also are employed in some instances for trimming and for loosening the masonry walls which were placed in various parts of the old tunnel sections by the railroad constructors. Contractors are required to remove the cut stones from these structures without damaging them, and they become the property of the turnpike commission.

The steadily growing popularity of detachable bits is evidenced by the fact that it is the present intention to use them at eight of the fourteen headings. The turnpike will therefore probably mark the most extensive application of detachable bits to be made thus far in tunneling operations. Although there will be some reconditioning of these bits on the job, most of them will be treated in merchant shops. One of these is situated in Pittsburgh, and another one has been established in McConnellsburg near the eastern end of the tunneling operations. In addition to reconditioning bits and drill rods, the shops are equipped to cut bar steel to length, to forge bits and shanks on it, and to recondition dulled or bent steels. They maintain a daily truck service to pick up and deliver material.

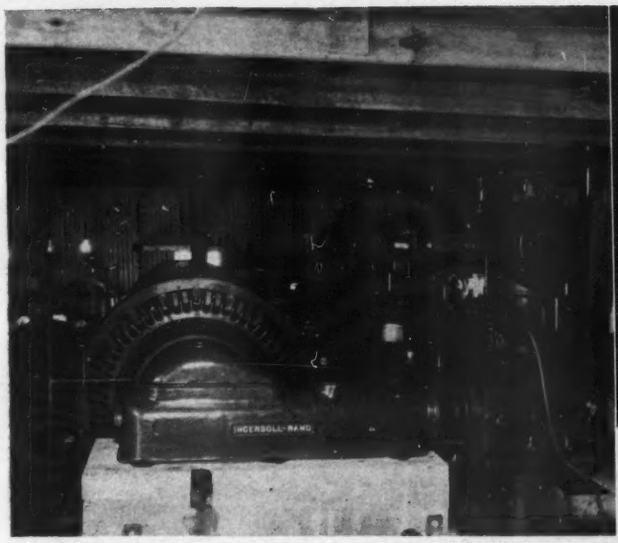
While mechanical loaders or mucking machines have been used to some extent in the preliminary work, shovels will undoubtedly be employed for all full-face mucking. Most of them will be electrically operated, but some diesel-driven units will be in service Dippers with capacities of 1¼, 1½, or 1¾ cubic yards are to be generally utilized. Equipment for transporting muck out of the tunnels is fairly evenly divided between rail cars and automotive units, the former having been selected for six headings and the latter for eight. Storage-battery locomotives predominate in rail haulage, with diesel-driven units also in use, particularly in yard service outside the workings. All automotive equipment is diesel driven, no gasoline-powered trucks being permitted in the tunnels because of the carbon-monoxide menace. In conformity with the turnpike commission's regulations, all workings are well ventilated, fresh air being introduced by blowers or fans located outside the portals. Some of the systems are arranged for either blowing or exhausting. Where these are present, smoke and powder fumes are exhausted for an adequate period following blasts, and at other times fresh air is blown into the workings.

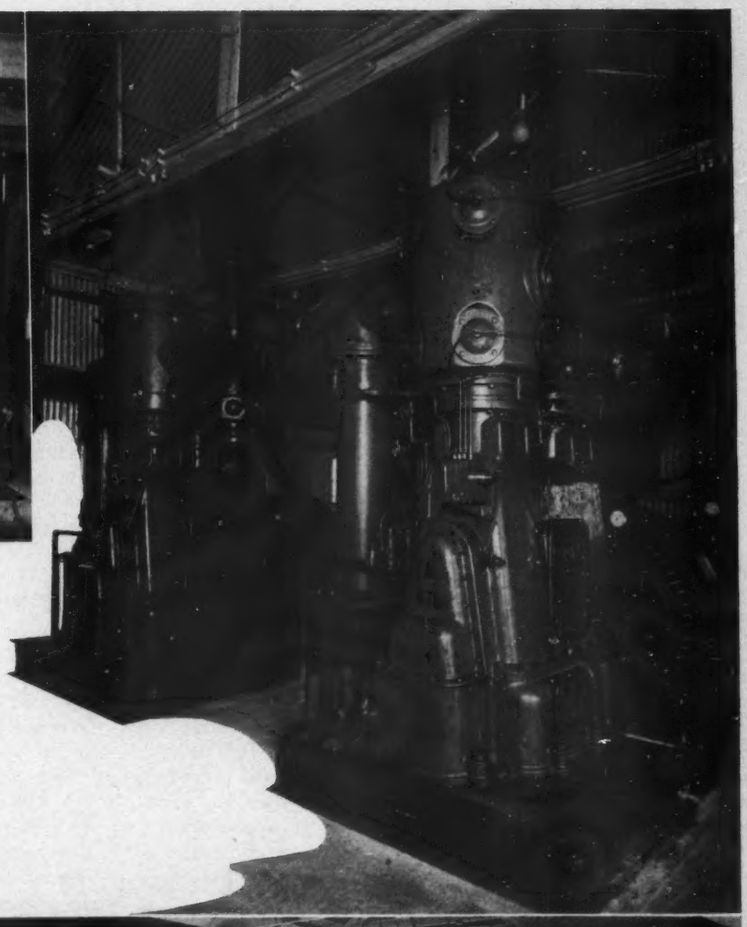
In preparation for lining the tunnels with concrete, all contractors have set up concrete batching and mixing plants and are acquiring stock piles of sand and aggregates. In at least one instance, at Laurel Hill, the contractor has opened his own quarry and crushing plant to supply the rock. In most cases, however, rock and sand will be purchased and will be shipped in by rail and trucks from varying distances. Concreting operations will generally be carried on from one portal only, thereby obviating the necessity of providing two plants and handling systems. It is estimated that 501,350 barrels of cement, 205,280 cubic yards of stone, and 104,840 cubic yards of sand will be used in mixing the concrete required for the lining, sidewalks, and roadway, and for doing the necessary grouting.

Proceeding from Harrisburg westward, the first tunnel on the highway will be Blue Mountain Tunnel. Between it and the next one through Kittatinny Mountain there is a gap of only 650 feet. The contract for both these bores was let to Bates & Rogers Construction Corporation of Chicago, Ill. With approaches, that section aggregates 2.348 miles. The driving of the east heading of Blue Mountain Tunnel and of the west heading of Kittatinny Mountain Tunnel was sublet to Boxley Bros. of Orange, Va., and Sammons & Robertson of Huntington, W. Va. The other two headings are being advanced by Bates & Rogers, who will also do all the concreting in both bores. Between the two tunnels is Gunter Valley in which flows Trout Run, a stream that provides some of the water supply of the Town of Shippensburg, a few miles away.

DRILL CARRIAGE

This gantry or "jumbo" is used by Mason & Hanger Company, Inc., in the west end of Ray's Hill Tunnel. It travels on rails spaced 22 feet apart, and the central opening is large enough to permit the loading shovel and trucks to pass through it. Five DA-35 drifter drills are mounted on the front of the carriage for enlarging the old tunnel section. It is expected that eight will be utilized for full-face drilling. At the lower left-hand side of the carriage is an Ingersoll-Rand pneumatic hoist that serves to pull the structure backward or forward. Two other air hoists, one of which is visible at the upper left, are used for handling drill steel as well as the structural steel that is set up for the support of the roof.





COMPRESSOR PLANTS

Stationary compressors located at each tunnel end furnish air for operating rock drills, pavement breakers, hoists, sump pumps and other essential equipment. These machines are of varying types and sizes, some of which are illustrated here. In the bottom view are six Motorcompressors arranged in three sets of coupled units, each pair being driven by one 200-hp. motor. They are used by the Bates & Rogers Construction Corporation, contractor for the Blue Mountain and Kittatinny Mountain tunnels. Two Type XRE-2 units, each driven by a 200-hp. synchronous motor, are shown above. They are at the east end of Allegheny Mountain Tunnel being excavated by Guthrie-Marsch-Peterson Company. The vertical machines (right) are PRV'S used by The Arundel Corporation at Sideling Hill Tunnel.

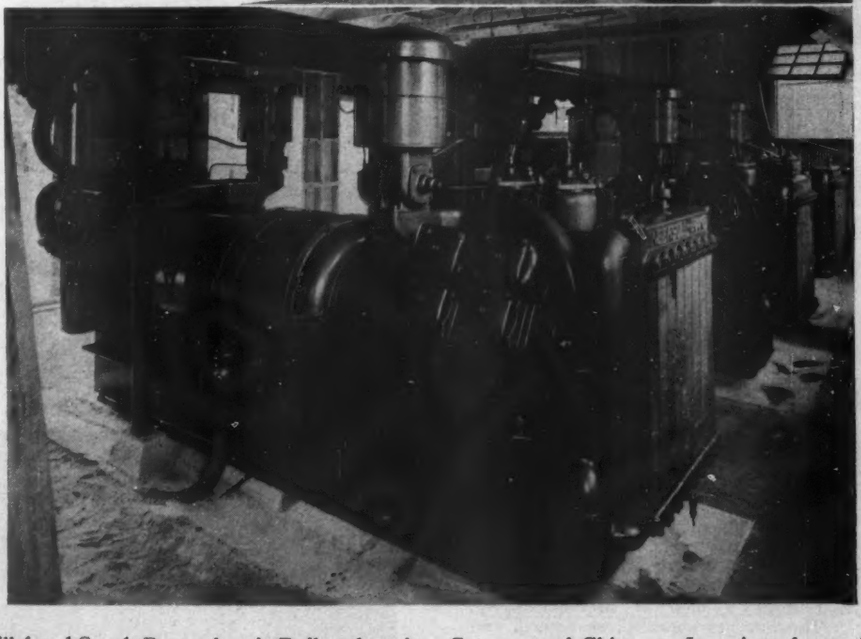
To avoid contaminating the run, extra precautions must be observed. All water flowing out of the tunnels is pumped over a mountain to another drainage basin, and all sewage, bath water, and other waste water is hauled away in tank trucks.

All but 551 feet of Kittatinny Mountain Tunnel had been driven by the South Pennsylvania Railroad. The excavated sections consisted of 1,870 feet of double-track width and 2,162 feet of single-track width. Good progress is being made from both portals; and it is expected that this will be the first tunnel on the turnpike to be holed through.

The next in succession, westward, is Tuscarora Mountain Tunnel which is being driven by B. Perini & Sons of Framingham, Mass. With the approaches, the contract covers 2.05 miles. A power line to the site was erected under subcontract by W. V. Pangborn of Philadelphia.

Then comes Sideling Hill Tunnel which, with 6,626 feet, is the longest of the group. With its approaches it constitutes a section 2.526 miles long. The contractor is the well-known Baltimore firm, The Arundel Corporation.

This is followed by Ray's Hill, where the tunnel and approaches make up 1.33 miles of the line. The contract is held by Mason & Hanger Company, Inc., of New York, a concern that was founded by Silas Mason in 1827. (Of particular interest is the fact that this company, then Mason & King, was the contractor for Tuscarora Tunnel under the ill-fated South Pennsylvania Railroad project more than 50 years ago. An associate firm—Mason, Hoge & Company—was the contractor for the Blue Mountain Tunnel.) Subcontracts were let to George Vang, Inc., of Pittsburgh, for clearing and grading the approaches, and to W. V. Pangborn for the construction of a power line.



West of Ray's Hill is Allegheny Mountain Tunnel, an entirely new bore that is being driven by Guthrie-Marsch-Peterson Company of Chicago. In point of actual yardage to be excavated, it is the biggest of all the tunnel jobs, for Sideling Hill Tunnel, although longer, had previously been advanced for nearly half its length. The contractor started out to drive the former by the heading-and-bench method; but, after penetrating about 400 feet from each side, decided to change to full-face attack, and is now proceeding on that basis. With the approaches included, this contract embraces

a section having a length of 1.78 miles.

Because of the comparatively shallow rock covering at the portals, special mining methods were adopted to get a safe distance underground without the risk of opening cracks in the roof or possibly causing falls. A narrow drift, with its roof at the spring line of the tunnel, was driven in from each side. After both drifts had penetrated a distance of approximately 46 feet, their inner ends were connected by a tunnel whose roof followed the arched contour of the larger tunnel section. Wall plates were then set at both sides and a steel-rib support put in place. From there the crews worked back to the portal, taking out only a narrow section along the roof and thereby extending the connection between the two side drifts. At intervals of a few feet, additional ribs were put in position.

With the roof thus securely held up, the next operation was to start at the portal and to work inward, removing the remaining rock down to a line extending straight across the bore a few feet below the spring line. The top heading thus formed was then carried forward a distance of 400 feet, at which point it was decided to adopt full-face excavating. During the driving of the heading, the drilling was done with JA-55 Jackhamers of the Ingersoll-Rand type, and the muck was loaded by means of a Conway mucking machine into cars running on a railroad laid on top of the bench. The bench was later removed by drilling with six DA-35 drifters mounted on a quarry bar, as illustrated in the picture on the cover. As bench excavating proceeded inward, steel side columns were set in place under the roof ribs and welded to the ends of the latter to transfer some of the load from the wall plates to the columns.

The westernmost tunnel, Laurel Hill, is being constructed by the Hunkin-Conkey Construction Company of Cleveland, Ohio. A subcontract for clearing and open-cut excavating was executed by Hinman Brothers of Denver, Colo. The contract covers 2.39 miles of line. As previously stated, it consists of all-new bore except for 773 feet at the western end. This section has already been enlarged, and full-face headings are now being advanced from both ends.

In opening the new east portal, a method similar to that employed at the Allegheny Tunnel was used. In this case, however, three small initial drifts were driven, one at the spring line on each side and the third at the crown of the tunnel arch. After they had penetrated a sufficient distance to insure adequate rock cover, the three were connected by small transverse tunnels, steel arch supports were set on wall plates, and excavating along the roof line was carried outward until the portal was reached.

A safety department, directed by T. W. Osgood, has drawn up regulations for the conduct of the tunneling operations to safeguard workmen against injury and disease. All persons going underground are required to wear "hard" hats; and steel supports are erected immediately after each round is mucked, the closeness of the ribs being discretionary with the commission's engineers. To allay dust, only wet drills are permissible. Tests of the air in the workings and of the drinking water are made regularly. An inspector for the commission is on duty at each tunnel at all times. Work in the tunnels is carried on 24 hours a day six days a week, and in some of the bores two shifts are employed on Sundays. Shifts are eight hours each, but no employee is permitted to put in more than 40 hours a week. Owing to a stipulation that Pennsylvania labor shall be given preference, and that persons on relief shall have first consideration for jobs, the tunneling crews have been recruited largely from groups having little previous experience in that type of work. However, they have now been trained for their jobs and, with the operations becoming better organized all the while, most of the contracts are proceeding rapidly.

The plans and specifications for the tunnels were prepared by a staff under the direction of Milton Brumer, the commission's engineer of tunnel design. As many of the old portals had caved in, confining water in the bores, it was impossible to enter them to obtain engineering data until the obstructions were removed. This could not be done until appropriations became available; and by the time funds were forthcoming, the engineers were being pressed to complete their part of the program so that construction might get underway as soon as possible. To meet this demand, the staff worked overtime for many weeks. The tunnel ventilating systems were designed by Ralph Smillie, consulting engineer.

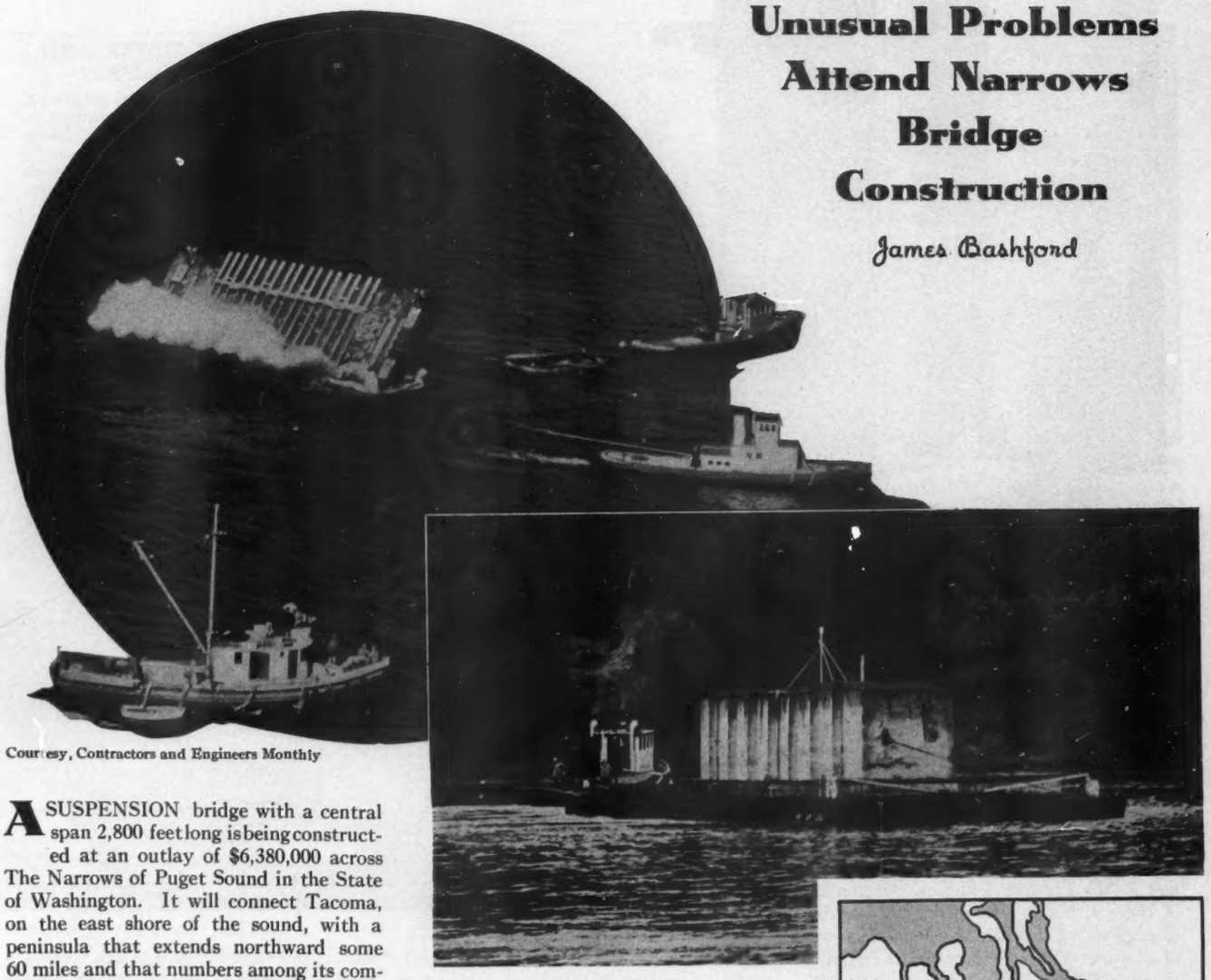
The construction of the tunnels is being directed for the Pennsylvania Turnpike Commission by Richard M. Merriman, chief engineer of tunnels. Mr. Merriman recently joined the commission staff after spending eight years in engineering work in California. From 1933 to 1935 he was superintendent of the Metropolitan Water District, and had charge of building 34 miles of 16-foot tunnels incorporated in the Colorado River Aqueduct. He is a brother of the late Thaddeus Merriman, who was chief engineer of the Board of Water Supply of the City of New York for many years.

RECONDITIONING DRILLING EQUIPMENT

Most of the contractors that are using Jackbits have them resharpened in one of the merchant shops that are servicing drill steels and bits. The picture at the right shows a furnace and a bit-quenching fixture in the Howells Mining Drill Company's shop at McConnellsburg. The bits are annealed, sharpened, and then hardened under accurate heat control. Above we see how The Arundel Corporation cleans out the bit ends of hollow drill steels that have become plugged. This is a tedious task when done by hand, but can be quickly handled by this method, which was introduced by Westley Grant, master mechanic at the west end of Sideling Hill Tunnel. An auger bit is fashioned on the end of a piece of 3/8- or 1/4-inch wire, and this is used for boring out the obstructing material. An Ingersoll-Rand No. 6 drill furnishes the power.

Unusual Problems Attend Narrows Bridge Construction

James Bashford



Courtesy, Contractors and Engineers Monthly

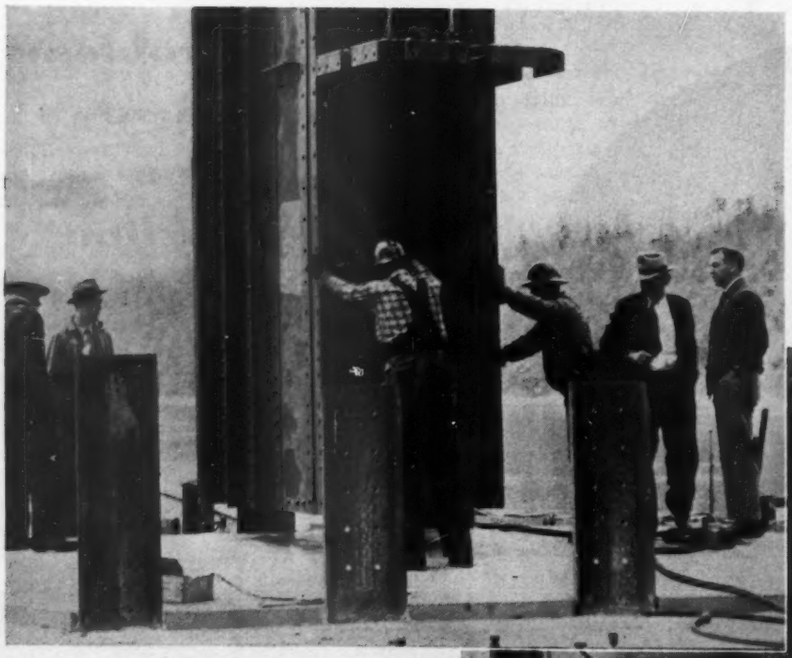
A SUSPENSION bridge with a central span 2,800 feet long is being constructed at an outlay of $6,380,000 across The Narrows of Puget Sound in the State of Washington. It will connect Tacoma, on the east shore of the sound, with a peninsula that extends northward some 60 miles and that numbers among its communities the Port of Bremerton, where an important United States navy yard is located. Direct access to this peninsula from Tacoma is now obtained by ferry only, and the alternate route is a circuitous land trip. The bridge is being built by the Washington Toll Bridge Authority and financed by a PWA grant of $2,880,000 and a bond issue of $3,500,000 that was sold to the RFC. Pierce County, in which Tacoma is located, furnished funds for preliminary exploratory drilling and also pledged $300,000 with which to purchase the ferry line that will be discontinued when the crossing is completed.

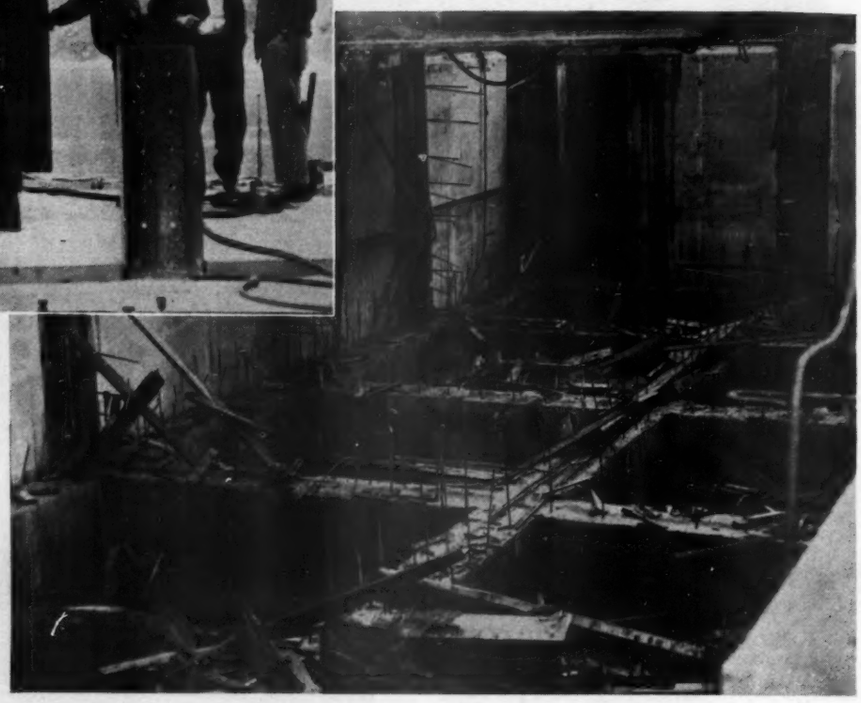
The side spans will each be 1,100 feet long, making the length of the bridge proper 5,000 feet. With the approaches, which will have grades of 2½ per cent, the overall length will be 5,939 feet. The deck structure will be 40 feet 8 inches wide, will have a clearance at the center of 195 feet above mean high water, and will have a 26-foot concrete roadway and two 5-foot walkways. The bridge has been designed to support a double line of closely spaced, loaded, 20-ton trucks. The two structural-steel towers for carrying the cables will rise 425 feet above their piers and will weigh 1,875 tons each. The cables will be 17¼ inches in diameter and each will be made up of 6,308 wires arranged in 19 strands of 332 wires each. The aggregate length of the wire will be nearly 15,000 miles and its weight approximately 4,000 tons. The work will involve the handling and use of large quantities of materials of which the principal ones are: wet excavation, 53,000 cubic yards; dry excavation, 137,850 cubic yards; structural steel, 10,325 tons; reinforcing steel, 1,750 tons; cable, wire, and fittings, 4,250 tons; concrete for structures, 111,380 cubic yards, and 5,200 square yards for pavement; timber for pier fenders, 1,230,000 board feet.

Because of the great water depth and the swift tidal flow, the placing of the foundation piers for the towers constituted an interesting engineering and construction problem. As an accompanying map shows, Puget Sound widens out appreciably both north and south of The Narrows, which is less than a mile wide. The distance from the bridge site to the Pacific Ocean is approximately 150 miles, and to the head of deep-water navigation at Olympia it is

ANCHORS FOR CAISSONS

Concrete blocks weighing 600 tons each were deposited on the bottom to form a circle around each pier site, and lines leading from them to the caissons held the latter upright and in precise position during their sinking in the deep, fast-moving water. In the center is seen one of the blocks aboard a barge and with a cable attached to its right side. The dumping of a block is illustrated at the upper left. The map shows the bridge location.





FIRST STEEL OF TOWER AND INTERIOR OF CAISSON

At the left, the first structural-steel member of the tower rising from the west pier is being lowered into place by workmen for the Bethlehem Steel Company. Below is a view inside one of the two pier caissons during construction. Each caisson was 119 feet long, 66 feet wide, and divided internally into 32 cells.

30 miles. The tidal range is about 17 feet. When the great volume of water that passes in and out of the inner sound four times daily reaches The Narrows, it sweeps through that constricted passageway with great speed. Measurements made 30 feet beneath the surface near the east-pier site during the construction period revealed an actual velocity of 12.46 feet a second, or more than 8 miles an hour.

As the depth of water with the tide out is 114 feet at the west-pier site and 130 feet at the east-pier location, the placing of these structures called for the exercise of engineering skill and cautious execution of all work. The piers were built by sinking structural-steel and reinforced-concrete caissons with cutting edges on the bottom. They were progressively lowered into the bed of the sound by dredging material up through them with clamshell buckets. The west caisson penetrated the bottom 56 feet and the east caisson 90 feet. After they had been seated on solid material, they were filled with concrete.

The caissons were approximately 119 feet long and 66 feet wide. The initial sections, which were 56 feet high, were constructed in Seattle by the Pacific Car & Foundry Company and towed to the bridge site by tugboats. Each caisson was divided into 32 cells, the principal ones measuring approximately 12x13 feet. The outside framework was built up of standard carbon-steel structural members, riveted together. This frame was encased in concrete and the exterior sheathed with timbers and calked. The outer wall had a thickness of 3 feet 4 inches, while interior dividing walls were all 2 feet thick and made of reinforced concrete.

Each caisson, when launched, was fitted with a watertight, removable timber bottom. It was towed to its prescribed location and then gradually sunk by setting additional sections on top of it. The steelwork was erected in 12-foot sections, after which concrete walls were poured. To facilitate these operations, a floating timber fender and platform was built up around each caisson but independent of it. The derricks for handling the concrete were mounted on the caissons themselves, because the swift currents in The Narrows made it impracticable to place them on floating barges. They were stationed 12 feet above the pouring level and periodically raised by the aid of four electric winches, one at each side. All were controlled by one switch so as to synchronize their action.

The concrete mixing plant was situated on a dock along the west shore. The mixers discharged into 3-cubic-yard buckets. Four of these were loaded on a scow at a time and towed to the caissons, where the derricks lifted them and poured their contents into the forms. The currents hampered concrete haulage and made it difficult to bring the craft alongside the caissons. On several occasions, scowloads of concrete were lost overboard.

The sinking of the caissons at their exact locations constituted a ticklish problem. To offset the action of the swiftly flowing water, the caissons, during this operation, were held in place and in upright position by anchors. These consisted of concrete blocks each measuring 12x12x51½ feet and weighing 600 tons. It was estimated that 48 blocks would suffice for both caissons; but subsequently their number had to be increased to 54, of which 24 were used for the west caisson and 30 for the east caisson. These anchor blocks were deposited on the bottom of the sound prior to the lowering of the caissons, and were arranged in circles around each pier site. They were cast on barges, towed to the points of use, and spotted for dumping. When the barge was moored, inboard gate valves on one side of the craft were opened so as to tilt it and to permit a block to slide overboard. The valves were opened by a tugboat pulling upon lines attached to wooden plugs fitted in the outer ends of the valves. This work was done during slack-water periods when there was no tidal flow.

Before a block was dumped, a steel cable was made fast to it; and all the lines from the several anchors around a caisson were attached to the latter to hold it in position during sinking. The cables were provided with adjusting tackle for increasing or relieving tension, as desired, the power for

this purpose being supplied by winches operated with compressed air. During the progressive lowering of the caisson its anchor lines were periodically reconnected at higher points by divers.

When the caisson had been submerged until it almost touched bottom, it was carefully maneuvered during slack water until it was precisely located. These operations were directed by two transitmen sighting from different points. Communication was maintained by means of 2-way radio sets. Contact with the water bed was then established by pumping water into the cells. This method was selected because it would have been possible to dewater the caisson and to refloat it for resetting if it had not been bottomed exactly. Fortunately, everything worked out as had been planned, and both caissons were placed correctly at the first attempt. The west caisson was brought to rest in daylight and the east structure at night. At the site of the east caisson the bottom sloped at an angle of about 20°. It was therefore leveled prior to the sinking operations by dredging the high side with a clamshell bucket. When the tide was running, most of the fine material was swept out of the bucket before it reached the surface, and even bowlders that were dumped were carried clear of the site.

After each caisson had been seated, the timber bottom was removed, exposing the cutting edges, and the operation of sinking the structure in the floor of the sound was begun. This was done by dredging material up through the caisson wells. The west caisson was anchored on March 20, and reached its ultimate footing on May 9. Seven weeks later the concrete had been poured and the pier structure above water completed; and on July 31 the erection of the steel tower was started. The cast pier was turned over to the steelworkers on September 15. Concrete for sealing the bottom of each caisson was conveyed through a 12-inch pipe. In the case of the east caisson, concrete was deposited 224 feet below the water's surface; and it is believed that a record for depth of pouring in salt water was then established. The overall height of the east pier is 198 feet and that of the west one 247 feet.

SAFETY FIRST

Deep water and swift tides constituted real hazards during the sinking of the caissons, hence the life preservers. From left to right: Walter Cathey, assistant superintendent; A. E. Graham, general superintendent; Harvey Donnelly, inspector for the state.

Work on the Narrows Bridge was started in November, 1938, and is scheduled to be finished by June, 30, 1940. The contract is held by the Pacific Bridge Company of San Francisco, Calif., the General Construction Company of Seattle, Wash., and by the Columbia Construction Company of Portland, Oreg. These three firms are handling the work jointly and are operating under the name of the P.G.C. Company. The Bethlehem Steel Company is erecting the steelwork; Woodworth & Cornell is placing the cable anchorage on the east side and building a section of the approach roadway; and Harrison Brothers are constructing a section of the approach roadway for the City of Tacoma. Lacey V. Murrow, director of the Washington State Highway Department, is serving as chief engineer for the Washington Toll Bridge Authority; Clark H. Eldridge is bridge engineer; and Charles E. Andrews, who supervised the building of the San Francisco-Oakland Bridge, is chief consulting engineer. For the contractors, Ralph T. Keenan is project manager; Theodore M. Kuss is chief engineer; and A. E. Graham is general superintendent. David L. Glenn is resident engineer for the PWA.

WEST CABLE ANCHORAGE

This block of reinforced concrete is 160 feet long, 70 feet wide, and extends to a maximum depth of 66 feet. It is made up of more than 20,000 cubic yards and, together with the structural steel, weighs in excess of 50,000 tons.

Shower Baths for Motor Cars

Allen S. Park

HAND-HELD WASHER

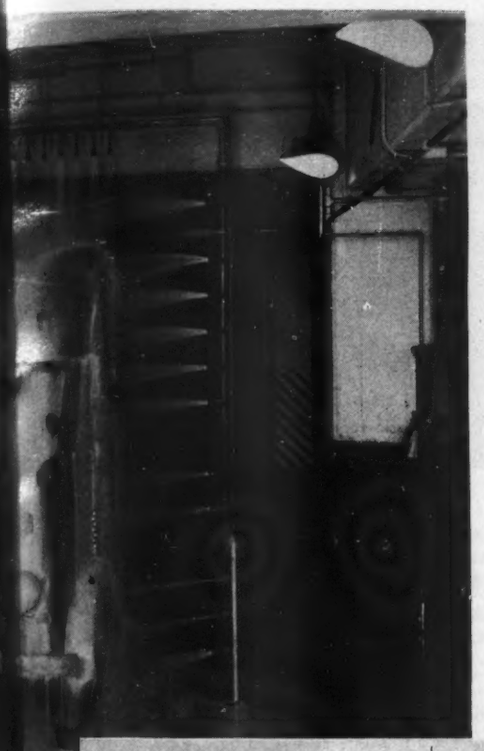
Illustrating (left) the method of washing areas not reached by the multiple sprays. Notice that the high-pressure stream of air and water does not spatter after striking a solid surface. This picture also shows one side of the multiple-unit washer framework and a close view of the nozzles.

AS EVERYBODY knows, the automobile is one of the mechanical marvels of our time. Coincident with its development, adequate means for servicing and repairing it have been produced. The motorist no longer needs to check his toolbox before starting on a trip, for wherever he may travel in the United States he is never very far from a service station. The presence of these facilities, plus the great improvement in the strength and durability of metals, rubber, and other materials entering into car construction, has removed apprehension over road failures from drivers' minds. Surprisingly, however, no proportionate advance has been made in the matter of means and methods of performing the lowly but necessary task of keeping automotive equipment outwardly clean.

We are still largely in the horse-and-buggy days so far as car-washing is concerned. In the average automobile service station, the common garden hose, a bucket, a bar of soap, sponges, cloths, and chamois skins are today the car-washer's chief working tools. Most, if not all of them, were used by our grandfathers when they "shined up" the surrey or the buckboard for the Sunday afternoon drive half a century ago.

There are exceptions of course, for some station operators and owners of large bus or truck fleets, though comparatively small in number, have added a few mechanical devices to expedite the washing process. By and large, however, it involves donning rubber boots, sloshing water around in wasteful quantities, and considerable muscular exertion in rubbing down surfaces both in cleaning and in drying them. Just why the old order has changed so little is hard to explain, for, even though it may come as news to most automobile owners, the average service station loses money in its car-washing department. Most establishments of this kind do the job primarily as an accommodation to customers. They look upon it as one of the services they must render and resolve to make the best of it and to keep expenditures for equipment as low as possible.

The largest single item entering into the cost of car-washing is wages. Obviously, then, the introduction of mechanical aids that will materially reduce the washing

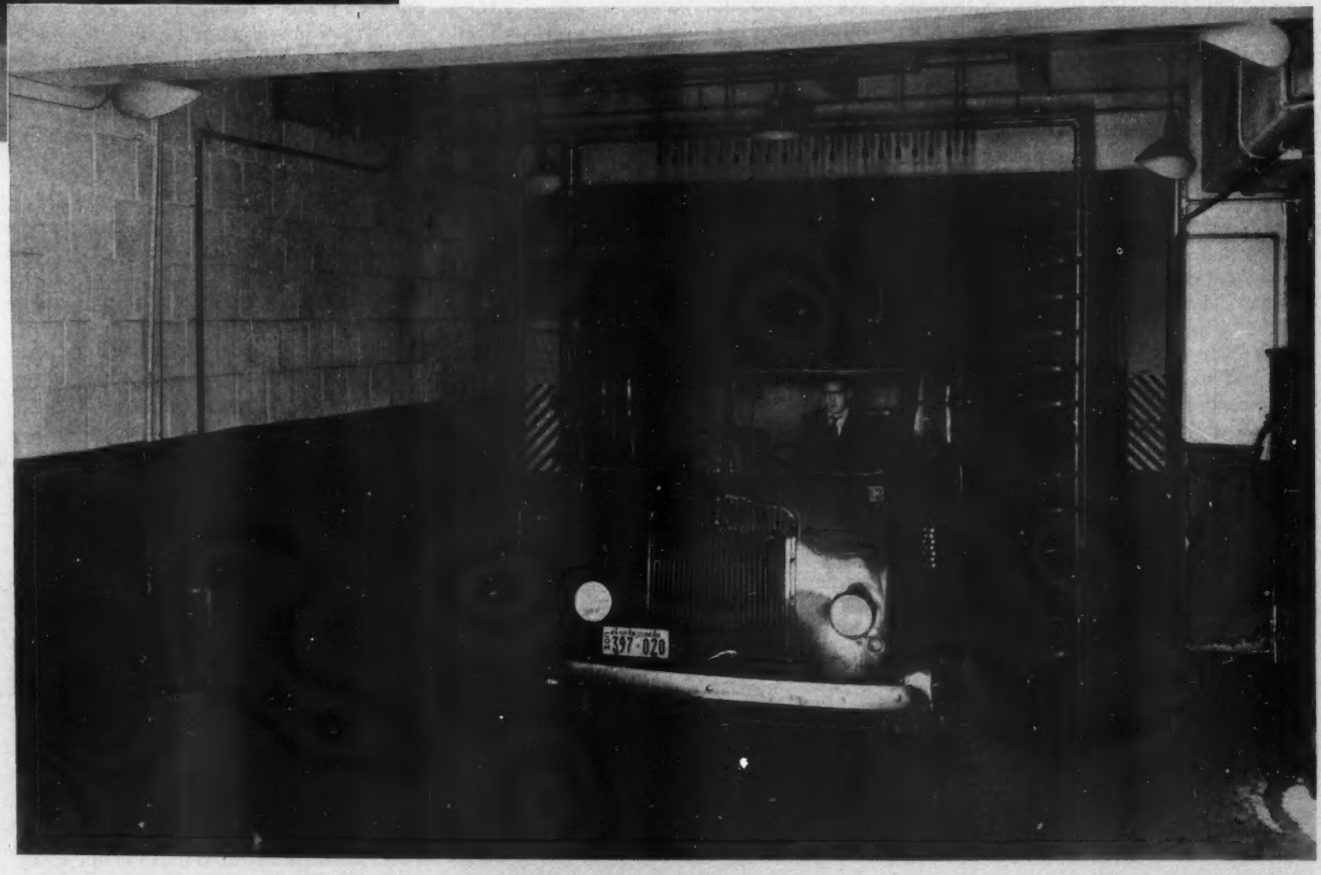


time will considerably cut the over-all cost. Any saving in time will, moreover, be welcomed by the customer who is often waiting to drive his automobile away. Depending upon the character and the amount of dirt upon a car, the washing operation now consumes from half an hour to an hour. Knowing this, many drivers postpone having the work done until they can conveniently spare that much time. As a result, the average automobile gets laundered rather infrequently, unless the owner elects to do the job himself at home in the evening or during a weekend.

The mechanical facilities that have been devised have come into existence mostly through the efforts of operators of large fleets. Bus and truck companies find that it is good business to keep their equipment in a spick-and-span condition. Clean, shiny cars engender good will, for the natural inference is that an establishment that pays close attention to the appearance of its vehicles also concerns itself with the safety as well as the efficiency of its operations. It is nothing more nor less than good housekeeping which, obviously, is as much to be desired in industry as it is in the home.

Naturally, the purpose of most of the efforts to improve washing equipment has been to provide more effective nozzles for directing the water stream. It was soon discovered that merely increasing the force of the water jet was not satisfactory. A high-pressure stream does remove dirt effectually, but it damages the car's finish. Gritty substances on the surfaces will produce scratches under such pressure just as surely as when they are rubbed with a cloth. Furthermore, once there is a minute break in the paint, water under high pressure will get under the film and scale it off.

Inasmuch as pressure is of course desirable, the problem was how to obtain it and at the same time eliminate its drawbacks. The best way in which to accomplish this seemed to be to inject compressed air into the water stream to break it up so fine as to rob it of its damaging effect. Among the nozzles designed to do this was one introduced some years ago by T. C. Bronstetter, of New York City, that has since been put in service in various parts of the world. The hose that is used in connection with



SOAPING AND WASHING

After an initial wetting, the car is covered with a soap solution (upper picture) and is then washed thoroughly by an air-and-water stream directed against it from both sides and above by 44 nozzles (lower picture). The operator stands at the left rear, where he manipulates the overhead valves on the air, water, and soap-solution pipes by means of chains. The drum containing the soap solution is shown at the bottom left. The outlet pipe through which the solution is pumped to the spray system by compressed air may be seen running up and along the wall. The hoses hung along both side walls supply air and water to two syphonic hand-held nozzles that are used to wash underneath the front fenders and rear wheel housing. Trucks are allowed to dry naturally after being washed. A special soap solution gives the paint a sheen and eliminates streaks. When the system is applied to pleasure cars, they will be dried quickly with a blast of warm air.

COMPRESSORS

The machine at the left, an ER-1 driven by a 10-hp. motor, was in place when the washer was installed. To provide more air, the 5-hp. Type 30 unit at the right was added. Although the washer makes use of considerable air, it is required only a minute or less at a time. To supply the volume needed, there are two storage reservoirs in addition to the one on which the right-hand compressor is mounted. The compressors are equipped with automatic start-and-stop control to cut in or out when the receiver pressure reaches predetermined points. The water pressure of the average city system is adequate for the multiple-nozzle washer, so that no pump is required under ordinary conditions.

it is divided internally into separate air and water channels. The air and water are brought together at the nozzle, where an adjusting lever makes it possible to vary the stream from a powerful jet to a soft spray. This nozzle, which is known as a syphonic washer, has proved effective and is a big improvement over the ordinary garden type of nozzle. It must still be wielded by hand, however, and this is time-consuming.

Recently, Mr. Bronstetter conceived the idea of building a multiple-nozzle washer that would direct numerous air-and-water streams simultaneously from different angles. The first apparatus of this kind lately made its appearance in New York City and has proved so successful as to give promise of solving the car-washing problem of service stations and garages. It consists of a framework of dual pipes, one for water and one for air. Two of the members are in an upright position, with the third one spanning the space between them at the upper level. Collectively, they resemble the goal posts and crossbar on a football field. The nozzles that extend from the vertical pipes face inward, each set spraying toward the other but at a slight angle from the plane between the two uprights, while those on the overhead pipe project downward. As a car is slowly driven between the uprights, sprays are directed on it from both sides and from above.

To increase the effectiveness of the system, provision has been made for applying soap or other cleansing solutions. This is placed in a steel drum from which, at a point near the bottom, extends a pipe connecting with the piping of the framework. The drum is closed airtight, and compressed air is forced into it at the top through a small pipe, thus pumping the solution to the spraying system by displacement.

The sprays are controlled by three valves, one each for water, air, and cleansing solution. These valves are overhead and are operated from one position by chains. As a car is driven through the frame it is first sprayed with water. Then it is backed up, the cleansing solution being applied the while. This is done by admitting only a small amount of water with the solution and opening the air valve wide, producing a fine spray that covers the automobile with a foamy lather. The vehicle is next driven forward again and washed with a combination air-and-water spray.

The head of each nozzle is a disk that has a diameter of 1 5/16 inches. Spaced around and within a circle 1 inch in diameter are more than 100 perforations, each one slightly larger than the diameter of a pin. These serve to divide the water stream into small jets, which are further broken up by the air that is introduced at the rear end of the nozzle. The air propels the water against the car surfaces with great force but in the form of millions of diminutive drops that create a mist. The number of the nozzles can be varied in accordance with the type of equipment being washed and determines the size of the piping. The installation under discussion is designed for large trucks. It has twelve nozzles on each side and twenty overhead, a total of 44.

Compressed air at a pressure of more than 100 pounds per square inch is used. In the case being described it is furnished by two machines. One of these is an Ingersoll-Rand straight-line, single-cylinder Class ER-1 unit that is V-belt driven from a 10-hp. motor. It has a piston displacement of 80 cfm. It will deliver air at a maximum pressure of 120 pounds, and is provided with an automatic start-and-stop control set so that the machine begins to operate when the receiver pressure drops to 100 pounds and shuts down when the receiver pressure reaches 120 pounds. The second compressor is one of the familiar Ingersoll-Rand Type 30 two-stage units which are regularly supplied for garage and industrial service. It is driven through V-belts by a 5-hp. motor and has a piston displacement of 20 cfm. It will deliver air at a maximum pressure of 200 pounds, but is equipped with automatic control to cut in when the receiver pressure drops to 100 pounds and to cut out when the pressure reaches 140 pounds. To insure an ample volume of operating air, there are two receivers in addition to the one on which the Type 30 compressor is mounted as it comes from the factory.

This multiple-nozzle unit will wash a large van-type truck in 48 seconds. It does a satisfactory job of all parts of the vehicle except the underside of the recessed wheel housing corresponding to the fenders on a pleasure car. These inaccessible surfaces are cleaned with hand-type nozzles. Two of these are provided, one for each side, and their water and air connections are independent of those for the multiple washer.

It is claimed that the multiple-nozzle washer will cut the water requirement per car to at least half of that of a single hand-operated, water-and-air nozzle. The saving is said to be even greater when compared with the water consumption of an ordinary nozzle or of a hose without a nozzle. Repeated use of the multiple unit on the same trucks has demonstrated that the fine spray does not damage the paint surface. In fact, it conserves the finish far more than does washing with sponges or cloths.

Such a washer is bound to prove popular with the workmen because they will not be subjected to the continual wettings which they experience under the old style of washing. The chains that operate the control

valves hang at one side of the pipe framework. Because of the finely divided spray there is practically no rebound or splashing of water from the car surfaces, and the worker remains perfectly dry. The degree to which the water is aerated can be gauged from the fact that a given volume of it is increased by 50 per cent when the air is turned on. In other words, each gallon of water will fill a gallon and a half of space after it is aerated.

A special study has been made of soap solutions to determine the most efficient and satisfactory one for use with the system. A. G. Glover, a well-known chemist who produced the car-cleansing compound employed in all service stations operated by the Sinclair Oil Company, has made up a formula for a cleanser that is said to give superior results when used with the combination air-and-water spray. It serves not only to clean thoroughly but also to leave the paint surface of a car with a glossy sheen that is free from streaks. In making up the solution for the system, the cleansing compound, a viscous liquid, is diluted with 40 parts of water. Mr. Glover furnished the first few drums of the compound in a form that would not saponify, create suds. However, the workmen using it could not be convinced of its cleansing value in the absence of the familiar white froth, so the chemist added a reagent to give the solution the characteristic that they demanded.

Mr. Bronstetter has already designed a multiple washer for pleasure cars. It is similar to the one described; but the overhead nozzles are arranged in the form of an arc which conforms to the shape of an automobile top instead of being in a straight line. The dimensions of the framework are smaller than those of the truck washer so as to bring the nozzles closer to the sides and tops of the cars. One of the large chains of service stations in New York City will soon install the system at one of its most important locations. If it proves popular with the motoring public, other stations will be similarly equipped. Cars will be dried quickly by blowing hot air on them.

The truck-washing unit under consideration is being used by the United Parcel Service at one of its stations in Long Island City, a part of greater New York. This organization handles all package deliveries for more than 300 stores in New York City, including those of substantially all the large department stores. It operates 1,100 trucks, and maintains facilities for keeping them in good running order. So-called "running" repairs—the correction of minor troubles reported by the drivers—are made at one or other of the 21 stations of the concern in the metropolitan area. Such repairs require only a few minutes' work, and a mechanic can ordinarily take care of from 30 to 35 trucks a shift. All repair jobs necessitating more than three hours' work are handled in a central shop which is completely equipped with machine tools, painting apparatus, etc. Hand-type syphonic washers are employed there to advantage. When trucks are dismantled, greasy parts are cleansed with these nozzles which make use of hot water and a soap solution. Hot water also serves to clean truck bodies, wheels, etc., prior to painting them.

United Parcel Service trucks have the reputation of being among the cleanest commercial vehicles on the New York streets. They are uniformly painted a Pullman brown. Their attractive appearance is maintained by washing each car in service every night. It will be apparent that this involves a great amount of work and expense, but the company considers it important that its equipment always look well. Its slogan, "The delivery system for stores of quality," appears on each truck, and every effort is made to live up to it. Motor equipment is under the management of Willard D. Bixby, a vice-president. Working under him is Joseph McLaughlin, superintendent of motor equipment.

The United Parcel Service is an interesting enterprise that is comparatively little known outside the communities in which it operates. Its president, J. E. Casey, started it in 1907 in Seattle, Wash. He began by delivering parcels for one of the city's stores by bicycle. Gradually he obtained more customers, and soon he had several cyclists working for him. Noticing Casey's success, another young Seattle man, Everitt McCabe, decided to get into the business. Motorcycles were becoming popular then, so he made use of them instead of bicycles. Casey recognized that they were superior to his slower means of locomotion and persuaded McCabe that it would be to their advantage if they pooled their interests. From that beginning the United Parcel Service has grown. It now handles deliveries for stores in virtually all Pacific Coast cities and has extended its operations to several other large centers in the country. It entered New York in 1930.

The organization's central station in New York is at Thirty-eighth Street and First Avenue, where it occupies the first four floors of a large warehouse owned by one of the city's leading department stores. Packages to be delivered within the city limits are taken from the stores to this station for sorting. Moving belts convey them to cages mounted on casters, each cage receiving the packages going to a certain area. When a cage is full it is wheeled into a truck backed up to a platform. Similar sorting stations located at convenient points handle packages consigned to the suburban sections of the city. Deliveries are made many miles away on Long Island, in Westchester County, New York, and in New Jersey.

Trucks are loaded and ready to go when their drivers report for duty. Each driver is accompanied by a helper, and each truck has a given quota of deliveries to make every day, the number depending upon the area covered. For packages handled in excess of the quota, drivers are paid a bonus. As many as 1,200 deliveries have been made by one truck in a single shift. The Christmas season naturally produces the heaviest business of the year, and about twice as many packages are then handled each day as in July. To take care of this Christmas rush, it is necessary that the company have trucks in reserve, and old vehicles are kept on hand for this purpose. Ordinarily, trucks are replaced every eight years; but there are some, taken over from the stores now served, that are twenty or more years old.

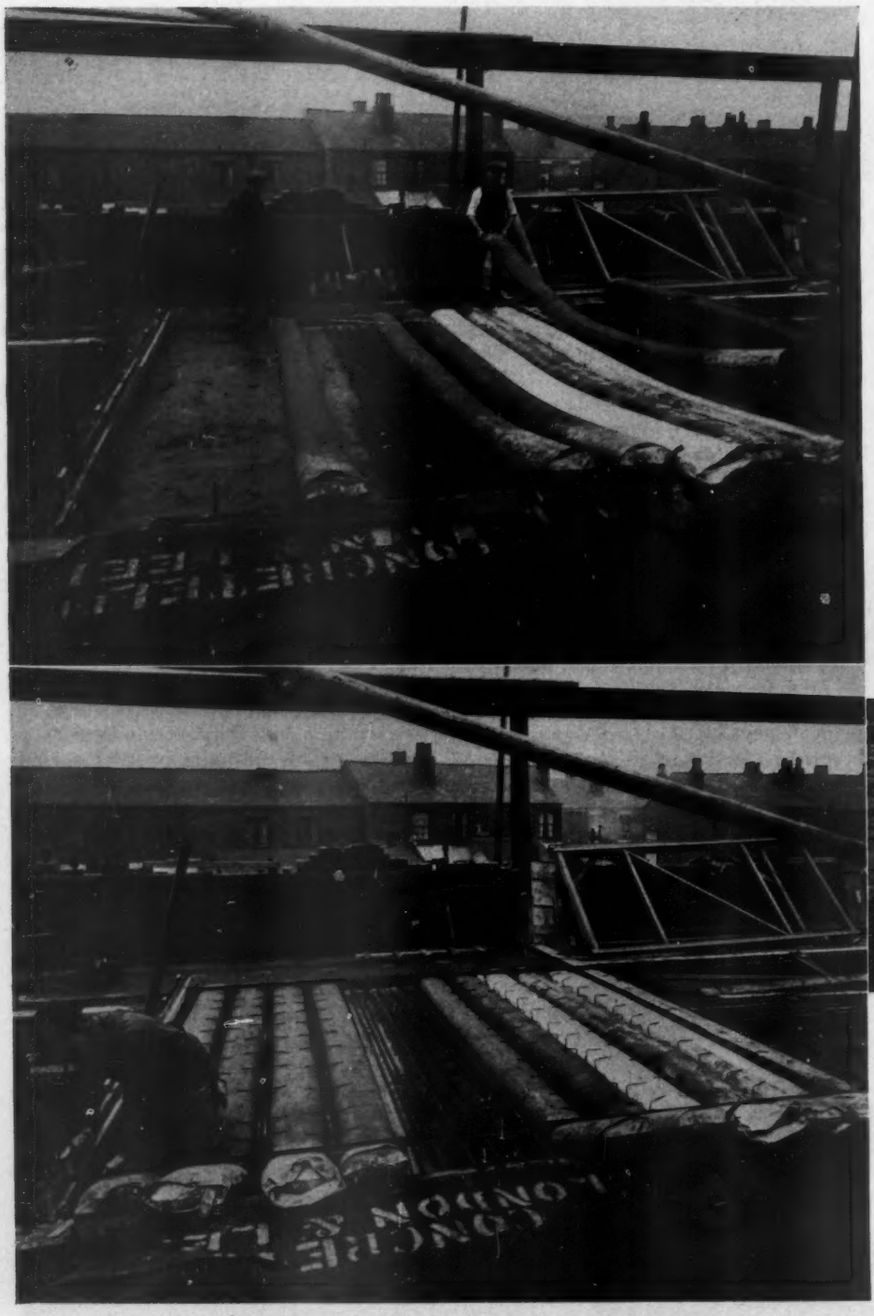
It need hardly be mentioned that a washing system by which trucks can be cleaned quickly is a valuable asset to concerns like the one described that operate large fleets, with most of the units in service many hours a day. Bus companies are in a similar category. This new development promises to place automobile washing on the same plane of efficiency as that on which the repair service has been for some years past. The multiple-nozzle apparatus would seem to be applicable also for cleaning railroad and street-car rolling stock. It is now being considered by New York subways and by several of the Class A railroad systems that enter that city.

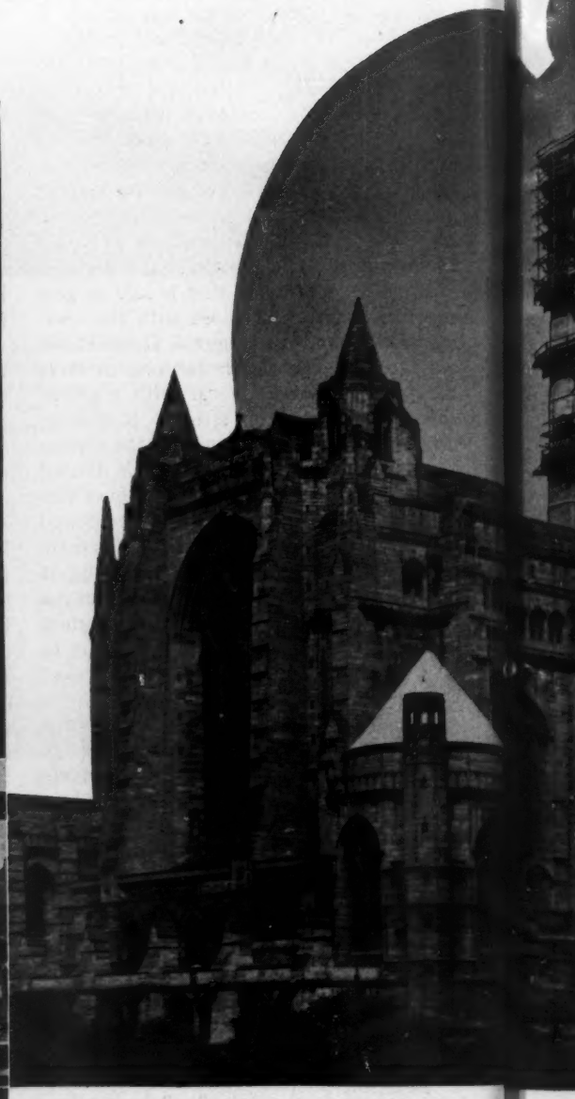
TRUCKS IN STORAGE

Some of the delivery fleet of the United Parcel Service. These trucks are all used for handling furniture. The unit at the left is the one shown in the washing pictures on the two preceding pages. It is 11 feet high and 28½ feet long. A total of 1,100 vehicles is operated to deliver the packages of more than 300 stores in New York City.

Air Puts Cavities in Building Materials

A. M. Hoffmann

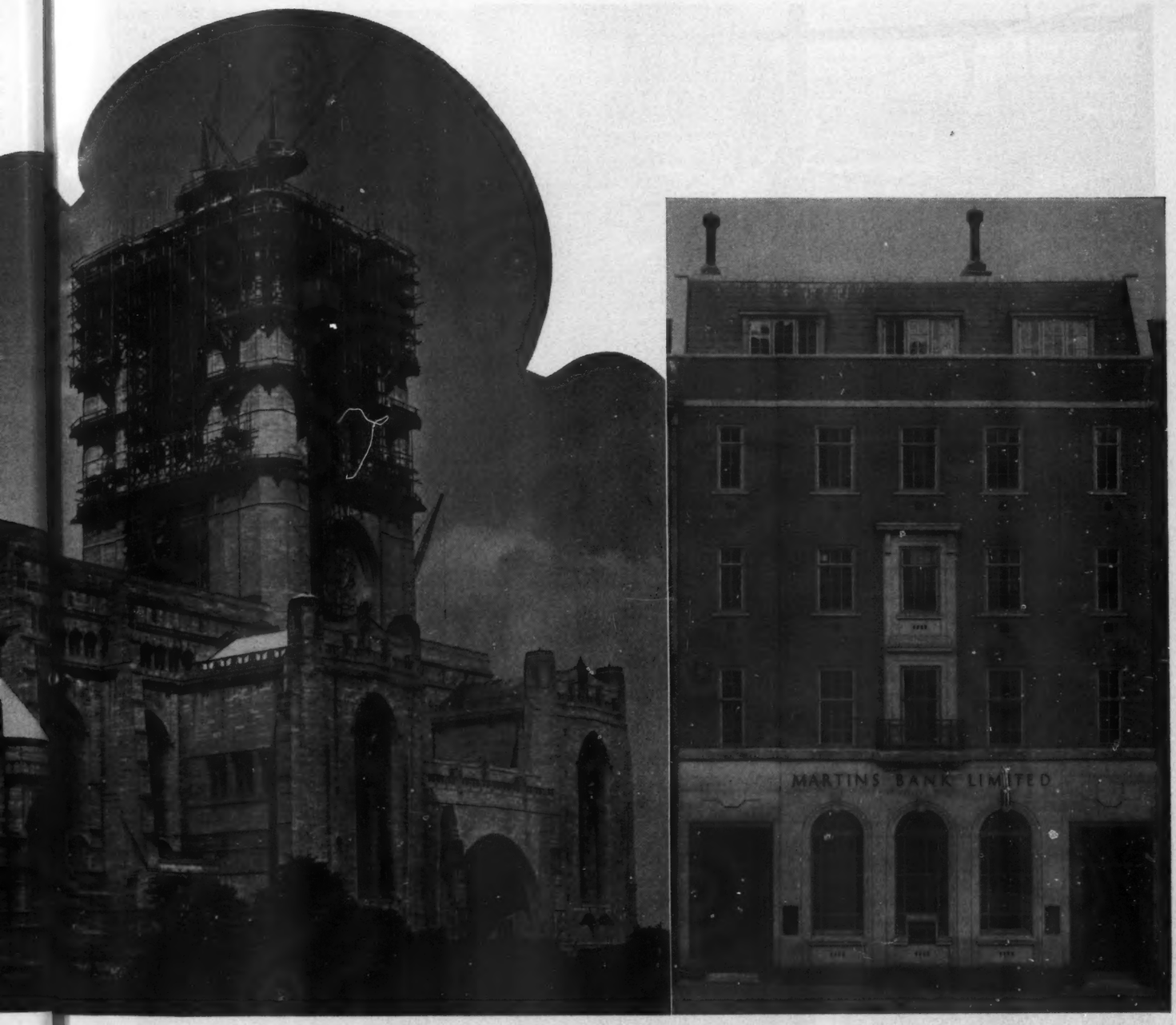




HOLLOW FLOORING CAST IN PLACE

Cores in protecting canvas sleeves and inflated with air at approximately 5 pounds pressure are being laid, top left, on concrete that was poured about four hours before this picture was taken. The cores are generally used twice each working day. Immediately above is shown the complete assembly ready for the top course of concrete. The space between the cores with the reinforcing rods will be a solid beam to support a wall. The man is securing one of the holding-down bars which determine the length of the slab. The Anglican Cathedral shown in the center is being built in Liverpool, England, and has Bison floors cast *in situ* throughout. Besides precast floors, the structure at the right has roofing made by the pneumatic-core method.

WITHIN the past two years, many public buildings, apartment houses, industrial plants, theaters, etc., have been constructed abroad with materials and by a system that, so far as we know, is unknown on this side of the Atlantic. Its chief virtues are that it promotes speed of erection and that it saves weight through the extensive utilization of hollow flooring, as well as wall beams and columns. While hollow building materials as such are nothing out of the ordinary, the method by which they are now being produced is decidedly novel. It is known as the Bison pneumatic core system, which makes use of patented withdrawable cores to form the cavities. This is now generally done by means of hollow clay bricks, which become an integral part of the structure and therefore represent an outlay that no longer



enters into consideration. The cores are used over and over again.

Bison concrete floors are either precast or cast *in situ*, depending on conditions. One way or the other, the cores are made up of one or more rubber tubes encased in canvas and are inflated with compressed air at a pressure of 5 pounds per square inch. Quantity production or precasting involves the use of molds, in which five floor or wall beams are manufactured at a time. For this purpose, the cores are wrapped in heavy Kraft paper to protect them and to facilitate extraction. When adequately expanded, they are placed in the mold and secured at one end by a metal holding-down bar. If the members are subsequently to be coated with plaster, they are provided with keyways which are formed by 4-ply cord laid lengthwise on the floor of the mold and spaced about 3 inches apart. The cords are later stripped from the finished beams.

With the preparatory operations completed, a roller conveyor carries the mold from the assembly floor to a vibrating table, where all the pouring is done from an overhead mixer. The concrete is made up of four parts crushed, washed gravel, two parts washed sand, and one part portland cement, with a percentage of calcium chloride added to expedite setting. The soffit or bottom is cast first. After the cores, which have temporarily been turned back out of the way, have been replaced and the reinforcing has been put in position, the sides and top are poured and rammed and the surface is troweled smooth.

From there, the conveyor transports the mold to a yard, where a crane stacks it with others for the initial set. Three or four hours later the cores are deflated and withdrawn, while the paper wrappers are allowed to remain in the cavities. Setting is facilitated by an electric heating system beneath the piles; and when the weather is bad, each is sheltered by a rigid, portable housing. Five-, 6-, 7-, and 8-inch-thick floor beams of varying lengths are cast in molds of standard size, the length being regulated by metal end plates which are slipped over the several cores and the thickness by the diameter of the cores or the amount of air forced into them. The actual time necessary to produce them is about twenty minutes, and they are ready for use within six to seven days. The work is done by unskilled labor.

Where precast floor beams do not meet requirements—where the span is longer

CORE WITHDRAWAL

Each pneumatic core, except in the case of mass production when Kraft paper is used, is encased in a canvas cover to facilitate withdrawal. The man in the foreground is holding on to a deflated core with one hand and a tape with the other. The latter leads through the sleeve and is fastened at its far end. By pulling this tape, after the core has been extracted, the canvas is easily peeled from the wet wall and removed from the cavity. The section on which the central figure is standing is a specially constructed safe-deposit floor.

than 16 feet, or where the cost of transportation would be prohibitive—Bison flooring is laid *in situ* in slabs or sections. On the whole, the operations are much the same as those already described. The bottom of the slab is poured in a temporary form, leveled, and allowed to harden. Next, parallel rows of cores, each in an extra canvas cover, are laid on top of the concrete and the reinforcing is put in place, the assembly being held firmly by metal bars, one at each end. The cores are light in weight and easy to handle, and can be walked on without damaging them.

As in the case of the precast beams, fast-setting concrete is used, and from three to four hours after the top has been poured, rammed, and screeded, the pneumatic cores are deflated and withdrawn. They slip easily out of their canvas covers, which are removed separately. This is done by pulling a tape, which extends through each sleeve and is fastened at the far or closed end. Under normal circumstances, the cores are good for about two years' service, while the protecting covers last about six months. The gap left for the extraction of the cores is then filled solid with concrete, which is suitably reinforced. The thickness of the flooring can be increased without adding to its weight simply by charging the cores with more air. Furthermore, the thickness of the bottom can be varied as and where desired to accommodate heating, gas, and water pipes, etc.

Hollow wall beams and columns also are being precast by the Bison pneumatic system. In the case of the walling, the width of the intervening air space is determined by the thickness of the core used. The standard size is 15 feet long, 14 inches high, and 5 inches thick, and consists of two slabs, each 1½ inches thick, held apart by numerous galvanized-steel ties each 2 inches long. When these units are set on top of one another they form a double wall with an unobstructed air space between them. This is of advantage, in that solid connections would tend to lessen the effectiveness of the air space as an insulator against dampness, heat, and cold.

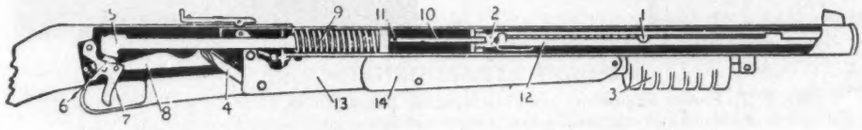
Walling is made in quantity much like the floor beams. While still wet and in the mold, the face to be exposed can be given an artistic effect by applying brick, sand, or stone dust, or some other pleasing finish, while the inner surface can be left smooth for whitewashing. Furthermore, the appearance of a brick wall can be obtained by placing thin bricks in the bottom of the mold and backing them with concrete. In that case, however, production as well as construction are somewhat slowed up because the bricks must be laid in even rows and the beams carefully selected so that the rows will continue in a straight line at the joints.

The columns have a maximum length of 15 feet and are erected on bases which have been prepared for them and from which project reinforcing rods. A firm anchorage is secured by pouring concrete into the cavity and ramming it around the reinforcing. Where necessary, a metal cage is lowered into the column before it is filled with concrete so as to increase its load-carrying capacity. Trough-shaped beams, tied to the tops of the columns by reinforcing embedded in concrete, complete the assembly, forming a strong monolithic structure. Window and door frames are put in position as construction proceeds; and to facilitate the rearing of the walls, the columns are cast with paralleling lengthwise grooves to receive the two members of the hollow beams.

With no forms to set up, no waiting for concrete to harden, it is apparent that much time is saved in putting up a building by this method. The materials are light and easy to handle; and because of the saving in weight effected by the elimination of the cavity-forming tiles or bricks, the weight of the supporting steelwork is proportionately reduced. Another advantage claimed for the pneumatic Bison core system is that it has lowered the cost of producing hollow building materials by nearly 20 per cent.

FINAL OPERATION

Filling in the gaps left at the ends of two slabs for the extraction of the cores. Where necessary, the exposed surfaces of the concrete are roughened to assure a firm bond with the freshly poured material.



THE DAISY PUMP REPEATER

The shot follower, *1*, forces shot from the magazine into the firing chamber, *2*. When the gun is cocked by pulling back the handhold, *3*, the cocking levers, *13* and *14*, move the cocking arm, *4*, forcing the plunger, *5*, backward and hooking its end over the top of the sear, *6*. When the trigger, *7*, is pulled, the mainspring, *9*, pushes the plunger forward, compressing the air in the chamber, *10*, and driving it through a small hole in the air tube, *11*, directly behind the shot. This pressure forces the shot through the shot tube, *12*.

How Air Guns Work

WITH the approach of Christmas, the air gun becomes a topic of conversation in many families. Among boys, an air rifle has been a coveted gift for several generations, and there is ample evidence that its popularity is continually increasing. The air gun bridges the span of boyhood years between the slingshot era and the age of discretion with a real rifle. It is a distinct boon to parents, for it enables them to indulge Junior's instinctive hunter-soldier propensities without placing in his hands a weapon of highly dangerous potentialities.

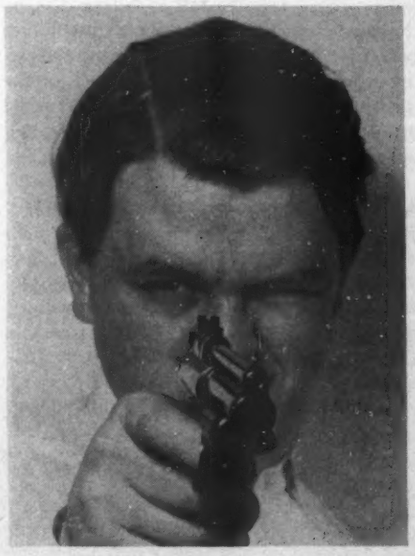
All air guns utilize the expansive force of compressed air for their firing, but they are of two types. The common form of gun is essentially a toy, and is charged or cocked by compressing a spiral spring one end of which forms a piston working in a cylinder. When released by a pull on the trigger, this spring expands and the piston compresses the air in front of it. The force of this air then propels the bullet through the barrel.

This kind of gun is made in various rifle models, ranging from single-shot types to double-barreled repeating types that resemble regulation shotguns. It also comes in pistol form. The ammunition is either size BB lead shot or .175 caliber copper-coated steel pellets. Guns working on the same principle but utilizing cork balls instead of shot are available for small children. Both rifle and pistol popguns are likewise made. In these the discharge of a cork retainer from the end of the barrel produces a loud report.

A more advanced type of air gun contains a compressed-air reservoir that is charged by means of a pump built into the gun. When the trigger is pulled, some of this air is liberated into a space behind the bullet, propelling the latter out through the barrel. A single pumping supplies enough air for as many as 25 shots; but as the pressure in the reservoir is reduced with each shot, the shooting force decreases unless the pump is used frequently.

These guns are made both in the form of rifles and pistols. They are closely akin to regulation cartridge-type weapons and have sufficient propulsive force to kill birds and small game. Some models will penetrate up to 1 inch in soft pine. Both rifles and pistols can be obtained with rifled barrels that add to their accuracy of shooting. According to one manufacturer's literature, the better types will group 2 inches from rest at 15 to 20 yards. This means that if the gun is held in a machine rest and accurately sighted on a target at the distance mentioned, repeated firing with the same air pressure will produce a pattern on the target not more than 2 inches in diameter. Guns of this type are made to shoot lead or steel BB shot, lead pellets of .177 or .22 caliber, or steel darts. They retail at prices up to $10 each, or about twice the cost of the better-class spring-type models.

Various efforts have been made to utilize air pressure for firing high-caliber rifles for hunting game and for military purposes. It is reported that guns using air instead of powder for propelling the shot were employed for a time by the United States forces in the Spanish-American War. They were known to the service men as popguns. Effective air-operated guns would possess a number of advantages over conventional types. Ammunition would be less costly, and they would require infrequent cleaning, as there would be no fouling of the barrel from powder smoke.



BENJAMIN PISTOL

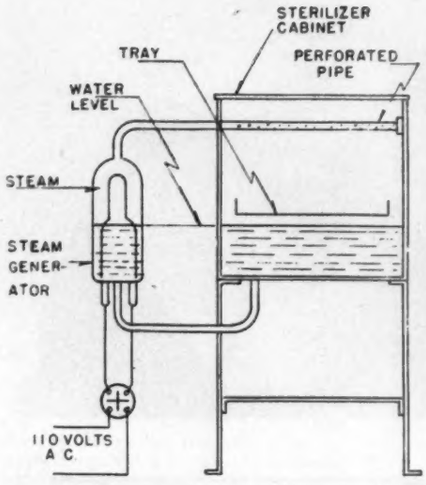
The lower cylinder is a pump which, when worked by the handhold beneath it, serves to compress air. This is stored in a small reservoir. Each pull of the trigger releases a percentage of this air behind the shot, forcing the latter out of the barrel at high velocity. A gun of this type is more than a mere toy.

Steam Generator for Small-Scale Operations

AN ELECTRIC steam generator of pocket size for a variety of medical, domestic, and industrial applications has been developed by the Lamp Division of the Westinghouse Electric & Manufacturing Company. It has an over-all height of only 9¼ inches and supplies superheated steam from tap water in 15 seconds!

The heating unit of this amazing little generator is housed in a glass bulb 2⅝ inches in diameter and capable of withstanding an internal pressure of 25 pounds. It consists of resistance wire wound compactly around a special ceramic core that is larger in diameter at the bottom than at the top. Eighty per cent of the wire is coiled around the lower section of the core and serves to boil the water brought in contact with it. This is the main winding. The remaining 20 per cent around the smaller end constitutes a superheater which can raise the temperature of the steam to as high as 350°F. before it is exhausted from the upper part of the bulb in which it accumulates. The temperature, of course, depends upon how much of the heating unit is exposed; but the water must at all times cover at least half of the main winding.

In service, the generator must be mounted at such a height in relation to the water tank or reservoir that the water level is up to the shoulder of the large-diameter section of the core. When so installed, the heater unit is immersed in 6 ounces or 0.216 pound of water, and high pressures cannot build up in the generator because the water is fed by gravity. In case of any excess pressure, the water is forced out and back into the reservoir, thus temporarily cutting down the steam supply.



DWARF STEAM GENERATORS

Mr. T. R. Porter, engineer of the Westinghouse Lamp Division, checking the performances of two of the company's new pocket-size steam generators developed for home, medical, and industrial use. The tiny glass-encased boiler is operated by means of a regular electric circuit. Operation is continuous, as the unit may be connected to the regular city water-supply system through the medium of a float chamber. The drawing shows the generator set-up with a tank—in this case a sterilizer.

The generator is available in 1,000-, 1,500- and 2,000-watt sizes, and is designed for operation with alternating current of 105-125 volts. Direct current is not used because of water electrolysis, which would take place to a limited extent. The units, in the order in which they are given, will evaporate 3.46, 4.2, and 5.7 pounds of water per hour when delivering steam at 212°F., or 2.2, 3.35, and 4.55 pounds of water when supplying superheated steam at 350°F. Their heating efficiency is said to be approximately 90 per cent. They are suitable for any service requiring a moderate amount of steam, and may be used for sterilizing instruments, glasses, dishes, etc., in doctors' and dentists' offices, restaurants, etc., for distilling water, and for numerous other purposes at home, in the laboratory, and elsewhere.

Pneumatic Conveyor for Zinc Ore

TO THE various bulk materials that are being successfully handled by pneumatic conveyors has been added a new one —zinc ore. The system in question is in use in wire-rope works in the Midlands, England, and is part of a storage and delivery plant required in connection with a new process of electrogalvanizing steel wire. The ore is crushed before shipment, and ranges from dust to ⅜ inch in size, weighs about 92 pounds per cubic foot, and contains approximately 6 per cent moisture.

The conveyor was furnished by Davidson & Company, Ltd., and delivers the materials from railroad cars to a 1,500-ton overhead storage bin, a maximum distance of 124 feet including a vertical lift of 65 feet. There are four flexible intake lines made of a specially compounded rubber and having a wear-resisting lining ¼-inch thick. The suction nozzle on each hose is provided with a rake that breaks up the ore, which has a tendency to pack in transit.

The unloading system is so arranged that any two lines can be used simultaneously, giving a capacity of 30 tons an hour, or 15 tons an hour with one line in service and the conveyor operating at half speed. Before it reaches the bin, the material passes through a separator of heavy steel-plate construction and thence through a rotary discharge valve into a distributing conveyor extending the length of the storage bin. The air flows into a battery of four multi-sleeve, fabric filters where it undergoes further cleaning before it is fed through a common main to the vacuum pump. The latter is V-belt driven by a motor having a rated capacity of 140 bhp. It can be run either at 720 or 360 rpm., depending upon the number of suction lines that are used to transfer the ore.

So that the filters themselves may be kept free of dirt and dust, each is equipped with an automatically operated cleaning mechanism that isolates it in turn from the suction line every two minutes for about five seconds. During this period, scavenging air is drawn through it in the reverse direction to the normal flow, thus effectually collapsing it and dislodging any material adhering to its inner walls. Any dust so collected passes through rotary valves to the distributing conveyor on top of the bin. This is of the enclosed worm type and has a number of discharge openings at equidistant points throughout its length through which the ore drops into the bin. The latter is provided with a number of bottom hoppers through which the zinc is fed to a series of enclosed worm conveyors, thence by elevator to a measuring bin, and from there to the galvanizing department.

THE TREND IN TOYS

PRIOR to the World War, the United States obtained most of its toys from abroad. During the period of hostilities, our own factories of necessity quickened their pace and have since continued to expand. Uncle Sam now makes more toys than any other nation. Accordingly, the present European conflict will in no wise lessen the number of toys that will be heaped at the foot of Christmas trees this year. So far as the ornaments for the trees are concerned, most of these colorful baubles come from Germany and Poland; but importers were well stocked with them before the war broke out.

Military toys have for many years been popular in this country. So far as the Department of Commerce can determine, the current war has not affected the demand for them one way or another, although it is said to have increased their popularity in the nations that are parties to the fighting. There has been much parental opposition to military toys on this side of the Atlantic; but leading psychologists say that they do not build up undesirable mental attitudes in children.

Mechanical toys have come to the fore in recent years. We are told that they are not modern inventions—that they originated in the Middle Ages in the form of figures of Biblical personages that moved their limbs and opened and closed their eyes. The French made mechanical toys in the eighteenth century, there being mention in a 1774 encyclopedia of a duck that swam about in water and ate bread crumbs. Movement was brought about, it is believed, by the flow of a stream of mercury, as it is known that both sand and mercury were often used in those days for animating elaborate toys.

Prominent among mechanical toys nowadays are miniature models of construction equipment. Power shovels, trucks, conveyors, and other types of materials-handling equipment are reproduced with remarkable fidelity as to details, and they appeal strongly to Young America. So far as we are aware, no manufacturer has yet brought out a toy air compressor or rock drill that will work; but their ingenuity will doubtless bridge this gap before long.

The American toy industry is big enough to be important. Gross sales reach approximately $230,000,000 annually, and are steadily mounting. There are more than 1,000 firms in the field, but half of them account for 95 per cent of the business. These factories give steady employment to around 30,000 persons; and in the busy season to 45,000. Two-thirds of all toys are sold during the Christmas period.

TURNPIKE EQUIPMENT

ONE of the outstanding features of the construction of the Pennsylvania Turnpike is the vast amount of large-capacity equipment being used. One investigator estimates that $30,000,000 worth of machinery will have been employed by the time the superhighway is completed. As this sum is approximately half the total estimated cost of the turnpike, the figure seems unduly high. Nevertheless, the array of mechanized equipment is imposing. The absence of horses is conspicuous, and shovels, picks, and kindred hand-wielded implements are infrequently seen.

All this is in striking contrast to the scenes one might have witnessed in 1884 and 1885, when the South Pennsylvania Railroad builders blazed the trail that is now being converted for the use of motor caravans. Men, mules, scrapers, wagons, and small tools then cluttered up the landscape. Virtually every pound of dirt handled was moved by the straining muscles of man or beast, or both. Internal-combustion engines had not come over the horizon, and such machinery as was available was driven by steam.

The outward effect of employing larger dirt-handling machines on such an undertaking is peculiar and misleading. The confusion that attended old-time roadbuilding jobs, with their jumble of animals, men, and equipment, is lacking. The shouts of mule-skinners are missing, and the muffled exhaust of gasoline and diesel engines can hardly match the strident tones of the human voice. The relative sparseness of equipment gives the impression at first that not much is being accomplished; but this opinion is subject to quick revision when these mechanical dirt eaters begin to indulge their prodigious appetites. Some of this equipment has to be seen to be appreciated. As evidence of its size, consider that one of the contractors is utilizing a carryall that travels on pneumatic tires 79 inches in diameter and costing $2,278 each.

There is one exception among the important machines to this trend towards larger sizes. It is the rock drill. So far as increased capacity is concerned, it has kept pace with all other types of equipment; but in the meanwhile it has continually become smaller. The reasons for this are improved design and advances in the metallurgy of steel. The old South Pennsylvania Railroad tunnel drivers used the Ingersoll "Eclipse" drill, a 345-pound piston-type machine that struck 300 blows a minute.

The invention of the hammer-type drill by J. G. Leyner revolutionized drill design and made possible the modern speeds of 2,000 or more blows a minute. Progressive refinements, together with the development of stronger steels, have supplemented Leyner's contribution and steadily increased the power of rock drills without adding to their weight. The DA-35 drifter, which predominates on the current turnpike tunnel work, has the same cylinder diameter as the "Eclipse," that is, 3½ inches. Yet the DA-35 weighs but 180 pounds, or a little more than half as much as the earlier model. Today's drill, because of its superior design, its faster action, its capacity for hitting harder, its far fewer breakdowns, and its power-feeding mechanism, does two to three times as much work as its predecessor of 1885.

Radiant Heat from Slag Used to Raise Steam

WASTE-HEAT boilers on reverberatory furnaces are among the latest improvements at the Douglas copper smelter of the Phelps Dodge Corporation. Each boiler is placed directly over the skimming end of a furnace where the tubes are exposed to the molten slag bath. The furnaces are 107 feet long and have an inside diameter of 26 feet. Each serves a single water-tube boiler of 2,600 hp. having a heating surface of 25,680 square feet and producing 60,000 pounds of steam at 400 pounds pressure and 460°F. an hour. At the end of the furnace arch there is a 7x28-foot opening through which the heated gases pass up to the nest of tubes whence they are exhausted to a flue with a damper 8 feet square. This leads to the main flue which is 15 feet in diameter and which discharges into the 300-foot furnace stack. The operating period of the boilers is about a year, and that of the furnaces is made to correspond by keeping the silica-brick lining of the arches in service condition by means of the spray-gun system of patching. The side walls of the furnaces also are lined with silica brick, while magnesite brick is used for the bridge wall and at the end of the charging zone.

Cleaning of the boiler tubes is done with compressed air at 80 pounds pressure per square inch and with soot blowers. The latter apply superheated steam and remove the loose dust near the tops of the tubes where the heat is not sufficient to cause sintering. It is collected in hoppers behind the mud drum and extracted from there and from the main flue once a week. With low-velocity gas, the dust accumulation amounts to approximately 4 tons a week per boiler. The daily ore charge for all the furnaces averages 1,016 tons, and the gas burned averages 3,030,000,000 Btu. a day. There is an unaccounted for heat gain of 8 per cent, and this is attributed to radiant heat from the incandescent slag bath. The boilers supply steam to a high-pressure power plant.

A NEW TWIST IN CONSTRUCTION KIBITZING

In December, 1938, we published a picture of the observation platform provided for members of the "Sidewalk Superintendents' Club" as a vantage point from which to watch the progress of the excavation for a new building in Radio City, New York. The photograph reproduced here shows the facilities arranged for onlookers at Park Avenue and Forty-Second Street, where the new Air Lines Terminal Building is rising. Each of the small signs near the top of the fence reads "Look Here," and bears an arrow pointing to a hole directly below it. These openings are at various heights, to accommodate persons of different statures. Near the sidewalk level are holes for dogs to peer through, with one very low one that is reserved for Pekinese. The Air Lines Knot-Hole Club has no officers, but it issues membership cards to those who request them. The contractor for the foundation of the new structure is the Albert A. Volk Company. The picture shown here was taken shortly after five o'clock. A light rain was falling, and most persons were hurrying to catch home-bound trains. Accordingly, few were tarrying long enough to qualify for membership in the Knot-Hole Club.

HOLDING THE FORT

This log house was directly on the right of way of the Pennsylvania Turnpike a few miles from Bedford, Pa. Its lone occupant, a man, chose to remain in it as long as possible, and was still there when this picture was taken, disregardful of the power shovel working less than 100 feet away. A few days later he moved out, and the house came down. A deep cut will carry the road through the hill on a slight grade.

New Scraper Mucking Manual

"MODERN Methods of Scraper Mucking and Loading" is the title of a new 183-page handbook written by the engineering staff of Ingersoll-Rand Company, 11 Broadway, New York. It is really a complete textbook on scraper mucking and loading and should prove of interest and value to all mine managers and superintendents. The volume is attractive in appearance and is profusely illustrated with instructive photographs and with line drawings showing various methods of scraper mining. Voluminous data are included in the descriptions of the typical installations that are pictured. The numerous applications of scrapers in the mining of metals, non-metallic materials, and coal are explored and covered. The designs of scrapers, hoists, ropes, sheaves, ramps, and slides are extensively discussed. This book is a distinct contribution by an equipment manufacturer to one of the industries that it serves. Executives of mining, quarrying, and contracting companies may obtain copies from any Ingersoll-Rand branch office without charge. A student edition sells for $1 a copy, and may be purchased from the book department of COMPRESSED AIR MAGAZINE.

Industrial Notes

New Air-Line Lubricator

OIL-IR is the trade name of a new air-line lubricator developed by Ingersoll-Rand Company for rock drills and a wide variety of pneumatic tools. The unit is 10¾ inches long and has a capacity of 1 pint. Its two ends are threaded identically and are reversible—that is, the OIL-IR works equally well no matter which end is connected to the air inlet when it is interposed in the supply line. It can be used and filled in either a vertical or a horizontal position.

In its passage through the lubricator, the air creates a slight vacuum, and this draws the oil through a pickup ring to a sealed needle valve which delivers the oil-laden air to the tool. The oil-feed can be regulated without taking the pressure off the chamber, in other words, while drilling is in progress. It is further claimed that the construction is such as to prevent the lubricant from being "siphoned back" into the air line when the pressure is released. This is effected by means of capillary attraction and a special separator that leaves the oil in the chamber and permits the air to escape. The lubricator is therefore not wasteful of oil; and, provided oils of the proper viscosity are selected, it will operate satisfactorily throughout the entire normal temperature range.

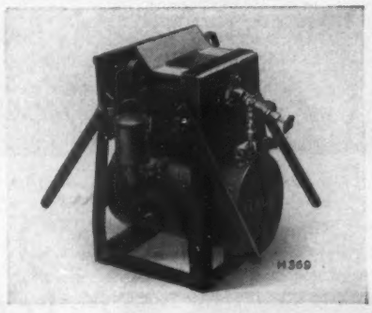
The company has prepared a folder, No. 2600, which describes the unit in detail. It can be obtained from any of its branch offices or by writing to the main office at 11 Broadway, New York, N. Y.

For the making of patterns and molds, Kindt-Collins Company is offering a new cement in powder form under the name of Master Dural. The material is mixed with water and will set in about 25 minutes. The claims made for it are that it will retain its dimensions and will not rot, mildew, or disintegrate. It can be used plain or shellacked, and the finished mold or pattern can be machined, drilled and threaded.

Instead of driving trucks and tractors requiring attention to a service station, the contractor on the Gila Canal siphon job in Arizona takes the service station to the vehicles wherever they may be out in the field, which covers a long front on the 17-mile Gila Canal. This mobile station is equipped to charge batteries, to inflate tires, and to do the necessary lubricating. It carries eight barrels of oil and grease, a ¾-hp. generator, and a small compressor, both driven by the truck motor through suitable connections. The air is delivered to a receiver mounted beneath one of the running boards, and from there is conveyed to a framework of piping erected on the deck of the truck and provided with a number of hose connections. Needless to say, this traveling service station is giving a good account of itself by cutting down the length of time the working tractors are out of commission, not to mention the saving in fuel consumption and wear and tear as a result of the reduction in mileage.

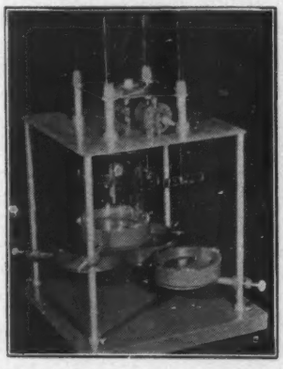
For the exclusive use of passenger coaches, the Southern Pacific Railroad has completed a yard with fifteen tracks: three storage tracks, which can accommodate 91 cars, and twelve servicing tracks for 177 coaches. Between the latter, which are generally 22 feet apart, are low platforms flanked by drainage gutters, and in the center of alternate platforms parallel with the tracks are overhead lines with numerous connections supplying compressed air, water, steam, and electricity.

Several different types of improved rivet-heating forges are being offered by Hauck Manufacturing Company. The one illustrated is the Handi-oil-forge which two men can carry and which can be operated on a scaffold or staging. The fuel is contained in a 10-gallon tank, which is an integral part of the unit, and is siphoned from it to the heating chamber by compressed air at from 30 to 120 pounds pressure per square inch. This forge burns 1½ gallons of oil an hour and consumes 6 cubic feet of air per minute with air at 60 pounds pressure. It has a normal capacity of 350 rivets of ¾x3-inch size an hour. A gas forge of the same



capacity with a high-pressure air-gas booster also is available. The furnace chamber of each of these units is of special design and vents all spent gases so that they pass upward and away from the operator. The new line includes wheel-mounted oil-burning forges with one or two heating chambers for quantity production of rivets of all sizes. In the case of the larger units, the operator is protected from the spent gases by a curtain of compressed air—the air for this purpose and that by which the fuel is siphoned to the oil burner being controlled by separate valves. According to the manufacturer, the new forges produce a steady, soaking, rotating heat and will provide white-hot rivets without scale and from a cold start in three minutes.

What has been described as an all-purpose agitator especially for laboratory service would seem to have much to commend it because it is equipped for multiple stirring and can, it is claimed, be used with inflammable liquids without hazard. The Air-Way, as it is called, has been put on the market by The Schoolmaster Company. It measures 14x14x20 inches, and has four beakers which are arranged at different levels between a top and bottom plate. They are set in cups, clamped to four uprights, and have a capacity of 1,000 cubic centimeters each—61 cubic inches. The stirring rods are of glass, are 5/16 inch



in diameter, and can be adjusted vertically. They are mounted in oilless bearings in the top plate and are belt connected in pairs to a vertical pulley driven by an air motor on top of the upper plate. The drive is reversible, the rods making a complete revolution first in one and then in the opposite direction, thus insuring thorough agitation of the liquids. They can be operated singly or simultaneously at varying speeds to meet specific needs ranging from gentle stirring to turbulent agitation, the degree depending upon the pressure of the air used to operate the motor. The pressure is controlled by a needle valve. Air at 2 pounds per square inch is sometimes adequate; but, whether the pressure is low or high, the Air-Way is said to work with equal efficiency. It is ready for service wherever compressed air is available.

Fire-fighting trucks built especially for airport service carry, in addition to their regular equipment, double banks of cylinders charged with compressed carbon-dioxide gas. The gas is used to extinguish gasoline fires.

Reykjavik, the capital of Iceland, is soon to inaugurate a unique hot-water service

that will require no fuel and will operate with but little maintenance. That city lies in a region of hot springs and geysers which spout water having a temperature of approximately 194°F. This water is to be tapped and distributed to homes and industrial establishments where it will be used for all but cooking and drinking purposes because of its sulphur content. A network of mains 9.3 miles long is being laid; and as most houses already are steam heated, it will mean providing only the necessary service connections. It is estimated that the heat loss in pumping the water over such long distances will not exceed 41°F., the pipes being heavily insulated. When completed, a year hence, this system of house-heating will save the inhabitants of Reykjavik around 34,000 tons of coal annually.

It is reported from Japan that a new process of manufacturing aluminum developed at the Tokyo University is to be put to practical use in a plant being built at Hachinohe, on the Island of Honshu, where ample power is available. The basic material is a phosphorus-bearing alumina (not the usual bauxite) found in Manchuria, and is treated with sulphuric acid to form aluminum sulfate. This, in turn, is treated with gaseous ammonia at a temperature of 2,192°F., the products being ammonium sulfate and aluminum oxide. Reduction of the alumina is by the customary electrolytic method. Handling 15,000 tons of ore annually, the plant will have an estimated output of 5,100 tons of metallic aluminum, 25,800 tons of ammonium sulfate, and 20,000 tons of fertilizer containing 20 percent phosphoric acid and 16 per cent ammonium sulfate.

To the average person, fog is fog; but to the scientist, who has been trying to find an effective method of clearing airports of the gray blanket that sometimes obscures them from overhead, fogs differ. According to David Brunt, professor of meteorology at the Imperial College of Science and Technology, there are two kinds: radiation fogs and those caused by the inflow of warm damp air over a cold surface. The former are created by the cooling of the earth's surface on a clear night when the air is fairly still. They present difficulties that have so far proved insurmountable. But fogs that have a measurable speed of motion, such as the second type, can, in the opinion of Professor Brunt, be dealt with, within limits, by the application of heat along the windward side. He claims that where 5 per cent of the contained moisture is in the form of droplets, where there is a variation in temperature of 41°F. between the bottom and the top of the blanket, and where the rate of drift is about 3¼ feet per second, the burning of 7,500 cubic feet of domestic gas is sufficient to dispel fog from an area about 325 feet high and 325 feet square.

SEALING PRESSURES SINCE 1888

For severe service conditions leading manufacturers turn to COOK'S "custom made" PISTON RINGS

because they have LONGER LIFE and REDUCE CYLINDER WEAR

COMPARE THESE FEATURES

- COOK'S GRAPHITIC IRON—a superior wear resisting and wear retarding exclusive ring material.
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ENGINEERS know that it takes more than ordinary piston rings to stand up in severe service equipment—equipment in which lubrication is generally poor because of extremes of pressures and temperatures and because the nature of the gas is destructive to lubrication . . . They realize that it takes rings of special design and special materials . . . That's why so many turn to COOK'S Rings, for COOK'S comprehensive line includes types and materials "Made to order" to meet these specific conditions.

Take a tip from these leading manufacturers . . . Turn to COOK'S Rings and cash in on the savings that invariably result from long ring life and reduced cylinder wear . . . Submit your piston ring problems to us . . . COOK'S engineers will produce the ring for the job.

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TINIZED* COOK'S GRAPHITIC IRON

*NON-SCUFF—QUICK-SEATING—ANTI-FRICTION METAL FACED

Piston Rings

IT COSTS SO LITTLE TO KNOW SO MUCH

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on every casting is a symbol of craftsmanship by Lebanon Foundrymen, modern artisans with the same traditions.

COPPER PENNIES for a paper—nickels and dimes for the wisdom of the world. The life of our great democracy insured by the unhampered distribution of information and knowledge—set down plainly on PAPER, for everyone to read.

Paper is not both cheap and good by accident. The chemist, the metallurgist and the mechanical engineer have pooled their experience for the more efficient and economical production of printing papers.

Pooled their wisdom, too, in placing their selective fingers on Stainless Alloy Steels to defeat corrosion in the paper making process. Lebanon Castings, made from exactly the right analysis of corrosion resistant alloys by the famous Swiss Chamotte method are licking climbing costs in paper mills from Maine to Puget Sound.

What these Lebanon Alloys are doing for the paper industry this year, they may do for your industry next year. We like to pioneer shoulder to shoulder with men of vision—to help keen management in any industry find ways of improving product or lowering costs through the use of Lebanon Alloy Steel Castings.

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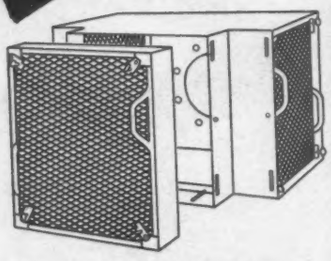
POSITIVE PROTECTION for DIESELS, GAS ENGINES and COMPRESSORS!

The American Air Filter Company offers the only COMPLETE line of air cleaning equipment available for engine and compressor service. Illustrated are 7 typical AAF filters. Please write to Dept. 422 for Bulletins indicated by number under each.

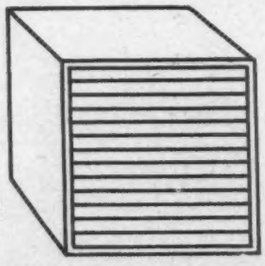
Outstanding among these is the Cycoil Oil Bath Air Cleaner—for equipment subjected to extremely heavy dust concentrations. The new Cycoil principle of air cleaning consists of a pre-cleaning action where the bulk of the dust is removed. Actually 4 distinct methods of cleaning are combined in the Cycoil—impingement, scrubbing, cyclonic action, filtration.

Write for Bulletin No. 130B for complete information.

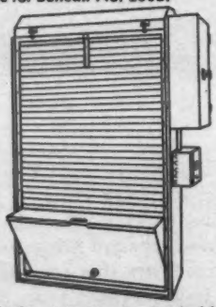
AMERICAN AIR FILTER CO., Inc.
INCORPORATED
LOUISVILLE, KY.



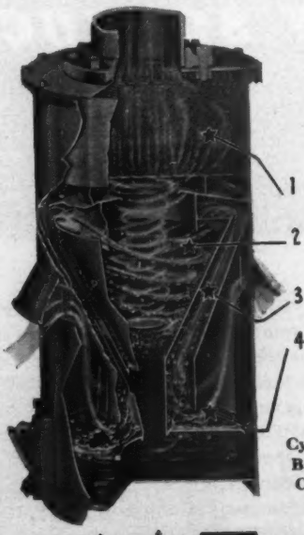
Type OC-HFilter—is a complete assembly consisting of washable viscous impingement type filters mounted in a housing ready to bolt to air intake pipe. 1 — 2 — 3 or more cells are employed depending upon the amount of air to be handled.
Write for Bulletin No. 120B.



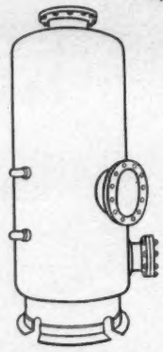
Type PL-H Filter—is a complete assembly consisting of housing, ready to bolt to intake pipe, and dry cell type filters in which wool felt constitutes the filter medium.
Write for Bulletin No. 230B.



Multi-Panel Automatic—is ideal for large units or multiple units using a common air intake. Its fully automatic, self-cleaning feature eliminates need of attention and assures satisfactory performance at times.
Write for Bulletin No. 240C.



Cycoil Oil Bath Air Cleaner



Cycoil Gas Cleaner—is suitable for practically every gas cleaning problem when temperature does not exceed 140°F. Provides four way cleaning on same principle as the Cycoil Oil Bath Air Cleaner.
Write for Bulletin No. 130B.

Type "E" Filter—is designed for small compressors and engines. It is a compact self-contained unit, provided with standard pipe thread for easy installation on the air intake of portable or stationary compressors, diesels, gas engines, blowers, etc.
Write for Bulletin No. 120B.

Type "G" Pipe Line Filters—assure clean, dry air for agitating and aerating liquids and protecting air hose, air tools, valves, etc. Available in wide range of sizes for every compressed air line service.
Write for Bulletin No. 121.

AAF

AMERICAN AIR FILTERS

JENKINS steel GLOBES

with service-proved construction at these 10 vital points

1—Liberally-Threaded, Stainless Steel Spindle*
2—Firm-Grip, Hand Wheel
3—Full Length, Bronze Yoke Nut
4—Husky, Nickel Alloy Packing Gland
5—Long-Life, Asbestos Gasket†
6—Handy, Cooling Chamber Plug
7—Bevel-Faced, Stainless Steel Disc*
8—Renewable, Stainless Steel Seat Ring*
9—Husky, Cast Carbon Steel Body‡
10—Five Convenient Bosses

†Corrugated Steel Gasket on Series 40 and 60.
**Trim also available in bronze, monel or steel.*
‡Body, Bonnet and Yoke also available in chrome molybdenum steel.

JENKINS Cast Steel Gate, Globe and Swing Check and Automatic Equalizing Stop and Check Valves are made in Series 15, 30, 40 and 60. Get complete details from your local distributor or direct from Jenkins Engineering Advisory Service.

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FIG. 1042, Series 30, Carbon Steel Globe Valve, Stainless Steel trim, for 300 lbs. steam, maximum temperature 750° F. — 600 lbs. non-shock Oil, Water, Gas at 100° F.

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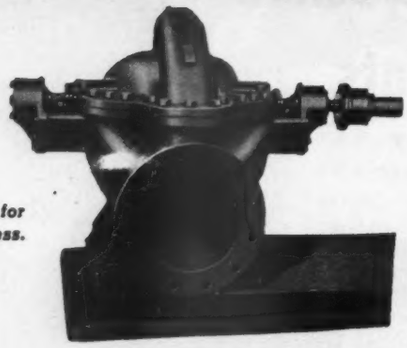
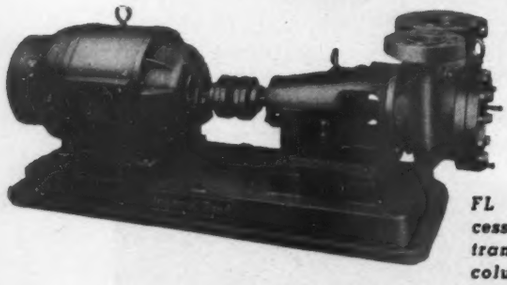
Equipment for

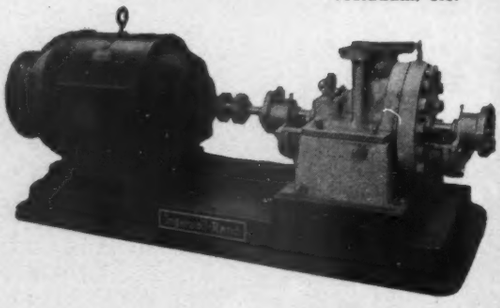


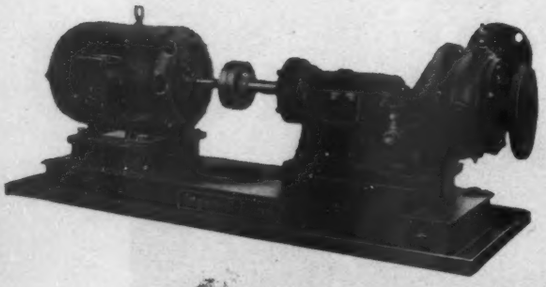
Acid recirculator for alkylation process.



FL refinery-process pump for hot transfer, naptha-column bottoms, residuum, etc.

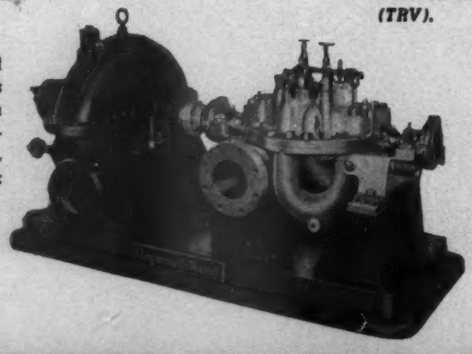
Heavy-duty single-stage pump for conditions of temperature and pressure more severe than normally handled by the FL type.





CRV pump for reflux and transfer service. Also available with built-in motor (Motorpump) or built-in turbine (TRV).

Two-stage GTR pump for hot liquids at relatively high heads — depropanizer-feed service, high-pressure reflux service, etc.



IN THE REFINERY

You will find Ingersoll-Rand on process work where uninterrupted, heavy-duty service of equipment is absolutely vital.

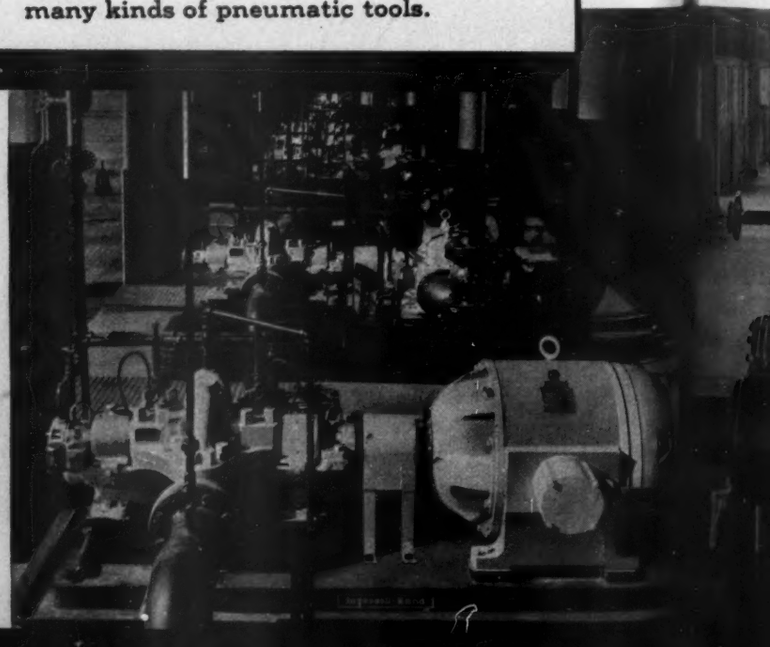
Ingersoll-Rand has kept pace with the continuous and rapid changes in refinery practice. . . . Thermal and catalytic cracking; polymerization; de-waxing; refrigeration, and now, alkylation.

I-R Cameron pumps are available for every refinery service in the manufacture of lubricating oils and gasoline.

Similarly, I-R compressors, blowers, and steam-jet ejectors have met every requirement demanded by the many new and severe refinery services.

In the complete line of compressors are all types for air and gas, with steam, Diesel-engine, gas-engine or electric drive. Sizes range from ¼ to 3000 hp, for pressures up to 15000 lb.

Other I-R products for refineries include hot-oil charging pumps, Diesel and gas engines, impact wrenches and many kinds of pneumatic tools.



...the Oil Industry

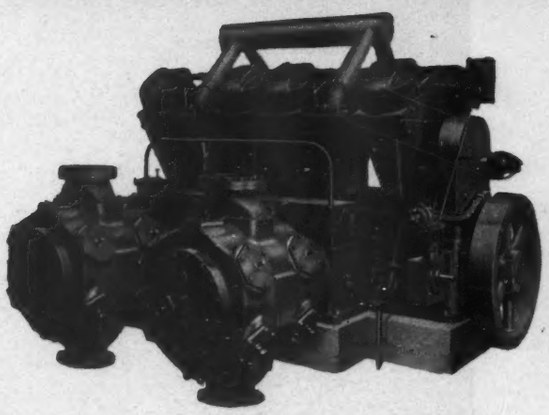
IN THE FIELD

Where 24-hour full-load operation is essential you will find Ingersoll-Rand compressors. For instance, over 150,000 hp of XVG gas-engine driven compressors have been installed. The more recent and larger LVG is enjoying the same popularity in extraction, repressuring and recycling operations. Steam, electric and diesel driven compressors are also available.

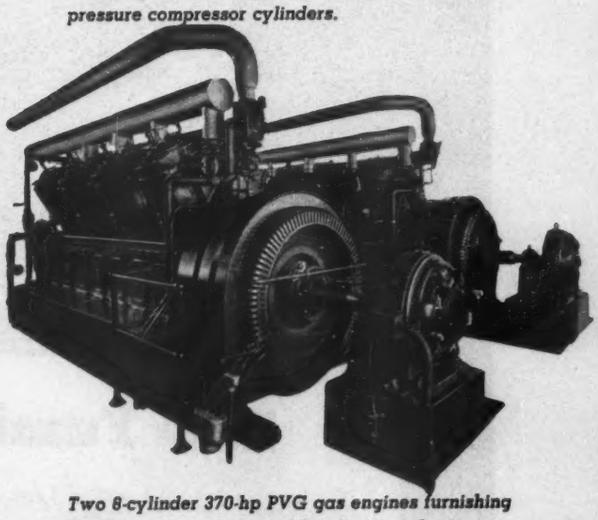
I-R Cameron centrifugal pumps meet practically all pipe-line and field requirements. Pipe-line pumps are frequently driven by gas or oil engines. Here, due to years of experience solving engine and pump problems, Ingersoll-Rand delivers combined engine-pumping units which give the utmost in reliability and efficiency.

The PVG and LVG gas engines are four-cycle, heavy-duty units ranging from 185 to 650 hp. Type SG four-cycle convertible oil-gas engines are available from 190 to 510 hp.

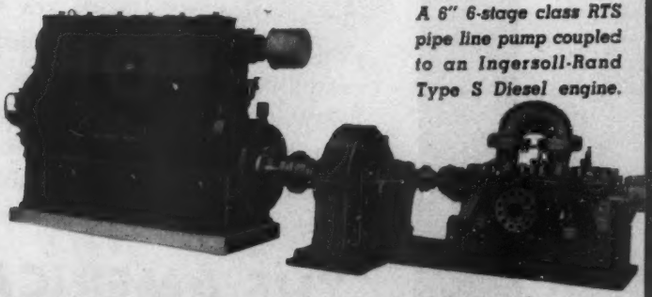
For trench digging, repairs, foundation work, steel erection, etc., I-R Portable Compressors and Pneumatic Tools find many money and time-saving uses.



A 650-hp LVG compressor equipped with low-pressure compressor cylinders.



Two 8-cylinder 370-hp PVG gas engines furnishing auxiliary power in a pipe line booster plant.



A 6" 6-stage class RTS pipe line pump coupled to an Ingersoll-Rand Type S Diesel engine.

LEFT: 300-hp 8-XVG compressors compressing gas in a repressuring plant.

Ingersoll-Rand

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Chicago	Duluth	Newark	Pottsville	Washington
	El Paso		Salt Lake City	

826-14

Low Fuming Welding Rods

ANACONDA 997 (Low Fuming) Welding Rod — high strength, tough weld metal with low fuming characteristics—has been added to the extensive line of Anaconda copper alloy welding rods. It is widely used for the general oxy-acetylene repair-welding of cast and malleable iron, steel and copper . . . It is particularly valuable where repairs must be made quickly and easily on machinery parts, automobile engine blocks and similar equipment. Anaconda 997 Welding Rod is manufactured under United States Patents Re 17,631 and 1,525,058. Available from supply houses handling Tobin Bronze and other Anaconda Welding Rods. 38250

THE AMERICAN BRASS COMPANY

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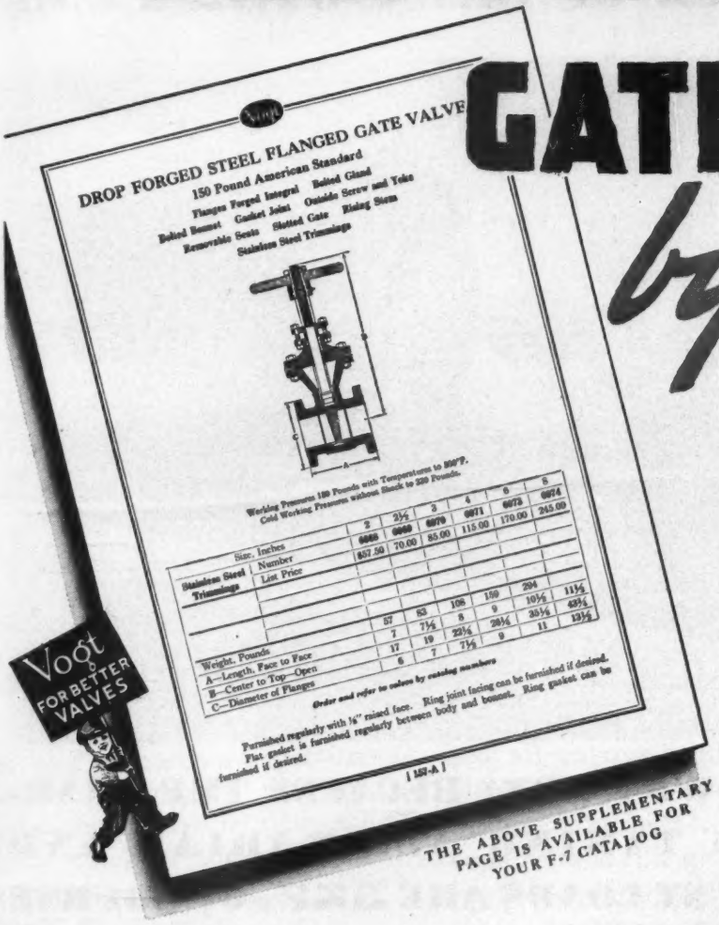
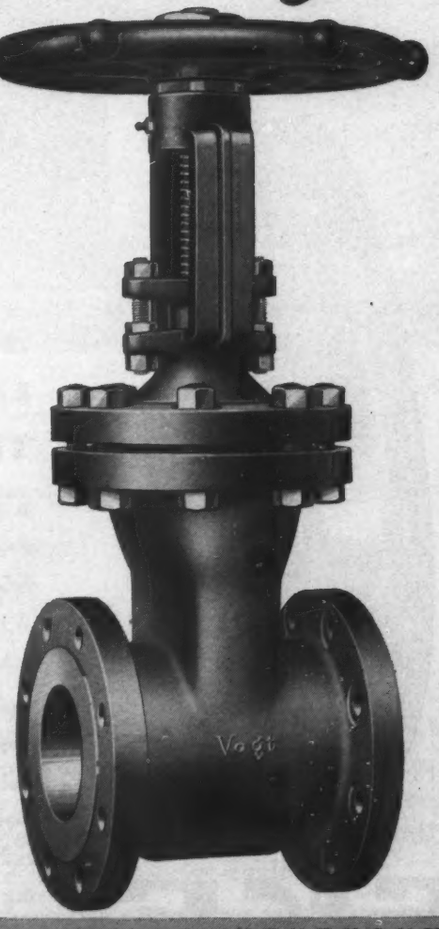
ANACONDA

Anaconda Welding Rods

New 150 POUND DROP FORGED STEEL GATE VALVES *by* Vogt


DROP FORGED STEEL FLANGED GATE VALVE
150 Pound American Standard
Flanges Forged Integral Bolted Gland
Bolted Bonnet Gasket Joint Outside Screw and Yoke
Removable Seats Slotted Gate Rising Stem
Stainless Steel Trimmings
Working Pressure 150 Pounds with Temperatures to 550°F.
Cold Working Pressure without Steam to 320 Pounds.
Size, Inches
Stainless Steel Trimmings
Number
List Price
Weight, Pounds
A—Length, Face to Face
B—Center to Top—Open
C—Diameter of Flanges
Order and refer to valves by catalog numbers
Furnished regularly with ⅛" raised face. Ring joint facing can be furnished if desired.
Flat gasket is furnished regularly between body and bonnet. Ring gasket can be
furnished if desired.
157-A
Vogt
FOR BETTER VALVES
THE ABOVE SUPPLEMENTARY
PAGE IS AVAILABLE FOR
YOUR F-7 CATALOG



VOGT LEADS AGAIN . . . . with a new line of 150 Pound A. S. A. *drop forged* steel gate valves ranging in sizes from 2" to 8" inclusive.

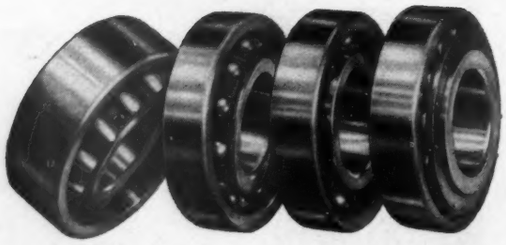
The design features . . (1) Body and bonnet flanges forged integral . . (2) Round bolted bonnet . . (3) Full port opening thru valve . . (4) Drop forged for extra strength and SAFETY.

GET HIGH VALUE for low pressure service . . Use Vogt 150 Pound A. S. A. Gate Valves.

Write for supplementary page 157-A

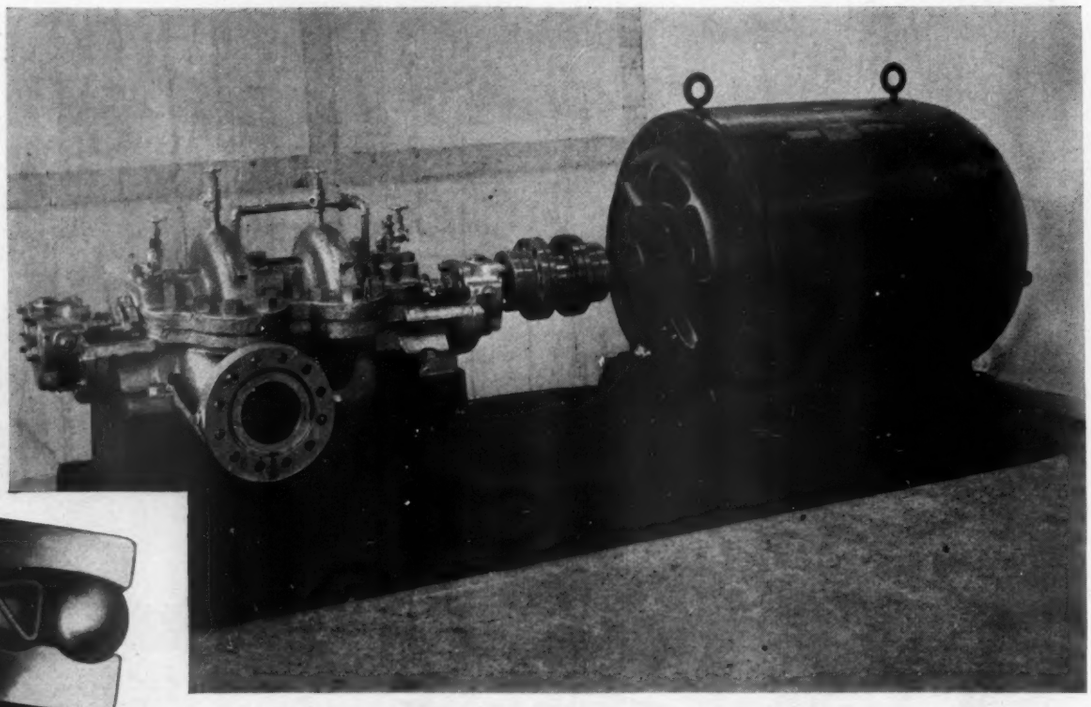
HENRY VOGT MACHINE CO., INC., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

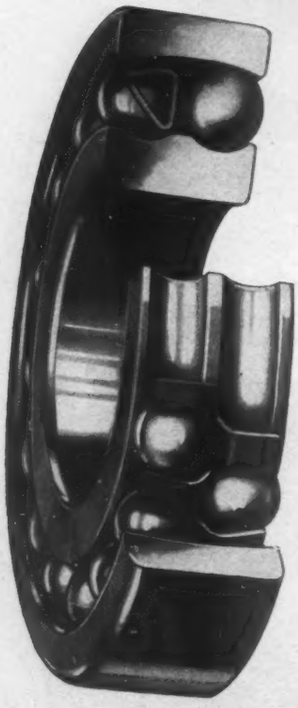


BEARING-WEAR

DOESN'T AFFECT THE SMOOTH, STEADY PERFORMANCE OF THIS 4-GTR2 PUMP



● *4-GTR2 pump built by Ingersoll-Rand Co.*



AND WHY NOT? BECAUSE THE BEARINGS TAKING ALL RADIAL AND THRUST LOADS ARE SKF, OF COURSE

● SKF Bearings are used on the rotor shaft of this 4-GTR2 Pump! Every revolution is so smooth that WEAR doesn't have a chance to get started.

On the thrust end, two matched angular contact bearings mounted back to back take radial and thrust loads in either direction. On the radial end, a self-aligning ball bearing is free to move in the housing to compensate for any differences in expansion or contraction between the shaft and the casing.

Consequently, these SKF Bearings resist WEAR effectively, and at the same time require no more attention than lubrication at long intervals. Merge the many advantages of SKF Bearings with the advantages of the equipment *you* build by seeing your local SKF representative TODAY. 4454

SKF

Ball and Roller Bearings

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA.

"TO THINK I'D O.K. A REQUISITION FOR A LOT OF SHOESTRINGS!"

That Was What One Paper Plant Superintendent Said Six Years Ago! But Today Texrope Drives Are Standard Equipment in His Plant . . . Providing Positive, Slipless Transmission . . . Saving Money Every Day! Read About Texrope Drives . . . Your Way to Lower Transmission Costs!

ONE OF TEN TEXROPE DRIVES IN A LARGE eastern paper plant, this 125 hp drive has been in continuous 24-hour operation since March, 1933, without any cost for replacements . . . is expected to go on giving 100% service for a long time to come!

The plant superintendent came in, took one look at workmen installing a Texrope Drive, and said—"To think I'd O.K. a requisition for a lot of shoestrings!"

That was six years ago in the plant of an eastern paper manufacturing company. And apparently the superintendent didn't think much of the first experimental lot of Texropes put on a beater in his plant.

But wait—read what happened next! They found that the "shoestrings" really stood up . . . even under the stress of 24-hour operation, day in and day out! Moreover, they found the Texrope Drive handled the beater as no other drive had ever done before—quietly, efficiently, with no slip or jerk, and not a penny spent for replacements!

That's why the superintendent now grins when he thinks of that day six years ago when he called them "shoestrings." For today Texropes are standard all through his plant. And every one of those original Texrope belts is still giving 24-hour a day service . . . beating transmission maintenance costs . . . making real savings!

You Save With Texrope!

Best of all — today, with new, important improvements, you get even better belt performance. For when you use Texropes, you get belts made with a new, special, cool-running rubber compound that gives longer life than ever before. What's more, they are sold in scientifically matched sets for equal pulling and long, even wearing.

To find out the power transmission savings that Texrope Drives bring you, get in touch with the nearest Allis-Chalmers district office or representative. Or write direct to Allis-Chalmers for money-saving facts. A-1138

Vari-Pitch Speed Changers • Texrope V-Belts • Duro-Brace Texsteel Sheaves • Vari-Pitch Sheaves • Standard Cast Iron Sheaves • Adjustable Pitch Diameter Texsteel Sheaves • 2-3-4 Combination Sheaves • Straitline Automatic Motor Bases • Oil Field Drilling Rigs

Belts by Goodrich

TEXROPE DIVISION

ALLIS-CHALMERS

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FRICTION PROOFED

by Timken Bearings

The Ingersoll-Rand Crawl-Air Compressor is equipped with TIMKEN Bearings on the crankshaft. This is in line with accepted practice in anti-frictionized compressors of all kinds.

TIMKEN Bearings assure full anti-friction performance including the carrying of radial-thrust loads and the holding of moving parts in constant alignment.

Make sure your new anti-frictionized compressor is Timken Bearing Equipped.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

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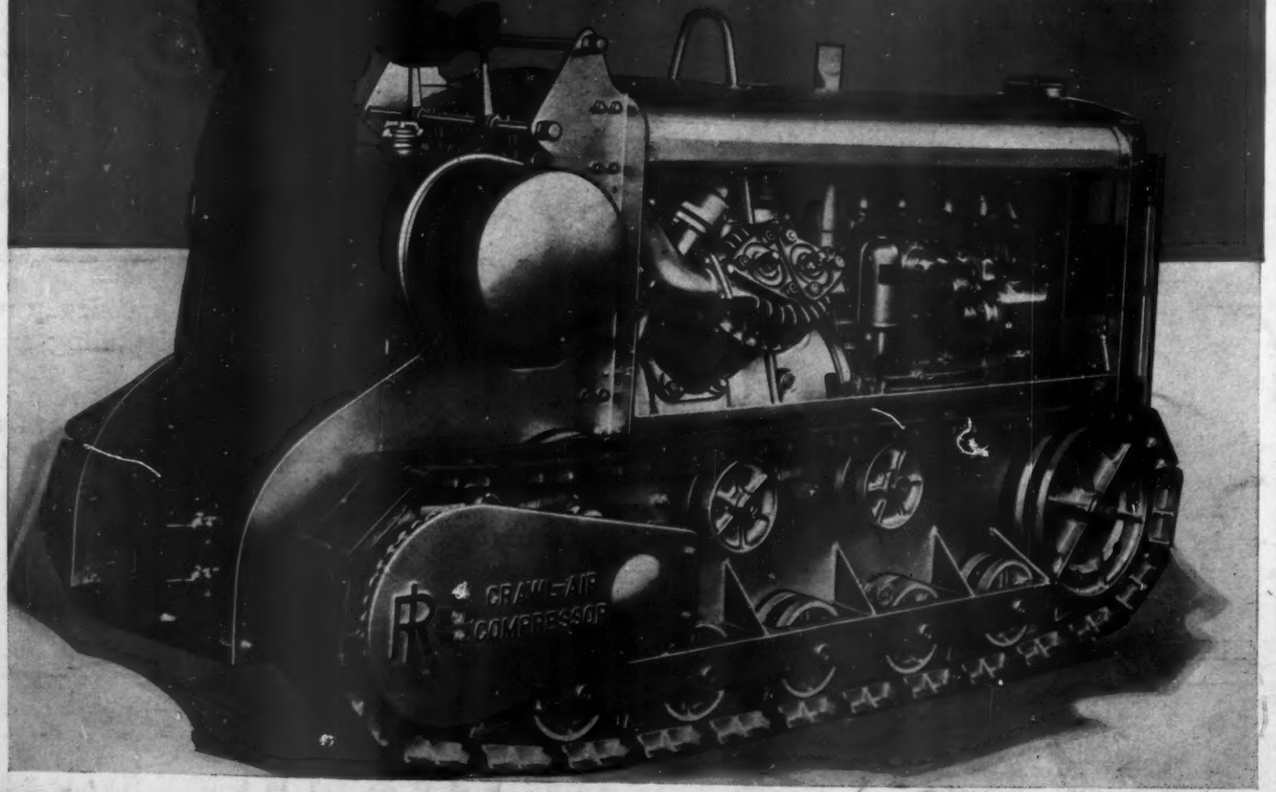
TAPERED ROLLER BEARINGS